

Part 1

Financial Modelling

Structure and Mechanics of Developing Financial Models for Corporate Finance and Project Finance Analysis

Part 1:

Financial Modelling:

Practical Development of Cash Flow Forecasts

Chapter 1: Financial Modelling and Recurring Valuation Nightmares – Problems that Financial Models Cannot Solve

An inevitable step in just about any financial analysis is making some kind of explicit or implicit projection of cash flow and/or earnings and/or various financial ratios. Since valuation of debt or equity is all about making forecasts of these items, you could go to a fortune teller or read the astrology section of your on-line newspaper to make your prediction of the future. These days however, forecasts used in valuation are more often founded on fancy financial models built using elaborate spreadsheets. After bursting of the dot com bubble in 2001, the global financial crisis of 2008, the European debt crisis in 2010, the East Asian crisis of 1997 and innumerable other less famous valuation disasters where debt and equity investment failures had relied on sophisticated financial models, it could be argued that going to astrologers and fortune tellers would have been a better strategy. Notwithstanding serious questions about the overall efficacy of making financial projections, the fact is that financial models are becoming more and more complex and are also being used more than ever before in all types of investment analysis. Seemingly sophisticated models using elaborate programming functions can appear impressive and even artistic, but at the same time be almost impossible to use in assessing risk and value. Given the prominence of modelling in financial analysis, this part of the book describes how to build flexible, accurate, structured and transparent financial models that can be used to assess various different valuation problems.

When considering many valuation mistakes made in the past decades, the most important pitfall in modelling is the development if economic assumptions for prices, volumes, capital expenditures and operating expenses in the models. If you take a step back and think about all sorts of financial failures ranging from the global financial crisis to bankruptcies of small business enterprises to industry specific failures such as solar panel manufacturers, there are a few patterns of mistakes that are repeated over and over again that seem obvious after the fact. Before delving into sophisticated mathematical equations, excel techniques and model structure issues that deal with methods to resolve difficult project and corporate finance and project finance modelling challenges, it is a good idea for you to think about why the outcomes of financial analysis using financial models sometimes fail so miserably. You can then leave these ideas somewhere in the back of your brain while you create the ornate excel models that follow all of the rules about flexibility, accuracy, structuring and transparency.

Some recurring valuation mistakes that continue to be made despite more and more sophistication in financial analysis and financial modelling are listed below:

- (1) Making assumptions in financial models that companies which are earning a rate of return substantially higher than their cost of capital and are growing quickly can continue this financial performance for a long time even when they do not have some kind of sustained competitive advantage. Earning a higher return than the cost of capital and growing seems to put a company in the famous powerhouse square on management consultant power point slides that is supposedly the best place to be for valuation. But when returns and growth are high, other companies from all over the world will attempt to enter the industry no matter how unique the company claims to be. This often leads to industry-wide over-capacity followed by reduced prices and sudden dramatic declines in returns. If demand growth is slower than expected which happens more often than not, the over capacity and depressed prices can last for many years. Examples of high growth and returns leading to industry expansion followed by surplus capacity and price crashes – the most basic economic principles -- include the famous telecom industry meltdown in the late 1990's; the merchant electric power

crash of 2000-2001 in the U.K where virtually every electricity plant without a fixed price contract defaulted on its debt; the real estate industry during many periods most notably before the U.S. crash of 2008; and, more recently where very high returns for solar manufacturing companies followed by massive new entry and dramatic price declines; high returns earned by bulk cargo vessels before 2008 followed by overcapacity and depressed prices that have continued long after commodity prices and other industries recovered; and depressed occupancy rates and room rates for hotels in Iquitos Peru that followed a period of over-building that was supposed to occur because of the region receiving UNESCO heritage site status.

- (2) Entering projected prices in financial models that remain above the long-run cost of production even when capacity is increasing in an industry. One can define a price bubble as a situation where prices do not equal long-run marginal cost and/or values are not consistent with levels that provide investors with a reasonable return on their investment. Assuming that prices can be sustained above marginal cost happened before the U.S. real estate crash where people believed they could profit by buying and selling (or flipping) homes; it occurred during the famous Tulip bubble in Holland in the 17th century; it may be happening in U.S. natural gas prices above the marginal cost of producing shale gas; and the assumption that prices could remain above marginal cost was behind just about all of the valuation mistakes discussed in the last paragraph ranging from the telecom industry crash to overproduction of container ships.
- (3) Using information in financial models that relies on so-called independent experts whether these people or institutions are credit rating agencies, large reputable corporations, consulting companies that create very fancy analytical models, experts speaking on television, famous finance professors, or former politicians. Many valuation nightmares have demonstrated after the fact that it is more important to visit countries, meet with real consumers, try out products and services, and have a through independent understanding the business idea than relying on so-called experts when developing projections. Reliance on entities like rating agencies was not only a cause of the global financial crisis of 2008, but has also occurred with traffic studies made for project financings such as the Eurotunnel, toll roads and toll bridges all over the world, theme parks and countless other cases. The famous Panama Canal catastrophe where French investors lost so much money in the 19th century resulted from trusting a famous engineer who had only visited Panama once. Relying on the reputation of companies that were thought to be the most innovative in their industry like ENRON, Worldcom and Lehman Brothers without thinking through the fundamental economics turned out to be very dangerous.
- (4) Trusting financial model results where increasing returns are projected by a company but the returns only come about because the company is taking on increased risks. Companies with declining returns or lower margins than peers often desperately try increase or maintain equity returns. But these companies (or individuals) can generally only meet their return objectives by take increased risks and then trying to hide those risks. When taking on ventures or deploying capital that involves taking greater risk, it is tempting for companies to directly or indirectly cover up the risks through not fully disclosing things or worse, using very sophisticated and confusing financial language along with financial models that are impossible to understand. Examples of valuation errors caused by presenting confusing information include Constellation Energy in 2006-2008, Enron's impossible to understand financial statements and innumerable financial institutions that made risky loans or engaged in risky trading behaviour to boost their returns before the financial crisis.
- (5) Ignoring shifts in the cost structure and demand change when creating a model which can quickly render existing assets obsolete. This is a particular problem in oligopolistic industries where seemingly stable returns and cash flows can suddenly change on the whim of management actions or changes in consumer taste. Think about Nokia, Research in Motion (blackberry) and Apple. A few years ago Nokia was the rage of investors and the company

was assumed to have unique products that would yield a sustainable competitive advantage and strong returns over an indefinite period. Then Nokia lost its lustre and Research in Motion was the poster child for investors. A few short years later, RIM lost its popularity and Apple became the most valuable company in the world as it somehow made people even more addicted to their cell phones. Commodity industries may be very volatile and not offer extraordinary returns, but at least you can apply basic economic principles when thinking about prices volumes, industry capacity and market demand.

- (6) Putting faith in fancy, complicated and innovative new financial paradigms when creating financial models. At the turn of the century the so called new economy was supposed to replace traditional analysis using cash flow and rate or return relative to cost of capital. At the time the new economy principles could explain why dot com companies do not need cash flow or profit to generate value; real option models were used to justify new peaking power plants that did not make economic sense using traditional discounted cash flow analysis; Collateralised debt obligations could supposedly reduce risk by putting a bunch of skanky loans to people who could not repay them. When such new models cannot be explained in simple terms and when the models explain why one can somehow earn high returns without having a sustained competitive advantage, they almost always turn out to be rubbish.
- (7) Having confidence in contracts that do not make economic sense and incorporating those contracts in financial models. Financial contracts that turned out to be unsustainable included sub-prime loans issued before the financial crisis, electricity contracts called PPA's in Senegal, India, Indonesia, the U.S.; the Philippines and many other places; construction contracts for large complex projects such as Eurotunnel and Eurodisney that are chronically underestimated; oil projects where ownership structures resulted in extreme economic profit for private investors; and, financial subsidies from governments in Spain and the Czech republic that lead to very high returns for project developers. In each of these cases financial projections made by analysts assumed contracts that would remain in place even though the contracts allocated risks in crazy ways and lead to prices and returns that were far away from economic reality.
- (8) Inputting symmetric upside case and downside assumptions in models without adequately considering differences in upward limits and downward exposures that create skewed returns. Not properly accounting for deviations between upside and downside variation led to the California crisis in electricity prices in 2000-2001; underestimating exposure to risk of nationalisation when oil prices are low; retiring large plants when prices are low and have much more potential movement to the upside than to the downside.

Chapter 2: How to Read this Book in Different Ways so You Can Learn Rigorous Valuation Techniques and Become a Black Belt Modeller

The four parts of this book explain how to: (1) build and interpret corporate finance, project finance and acquisition financial models; (2) perform risk analysis using all kinds of financial models; (3) use mathematical programming to resolve circular calculation problems in corporate and project finance models; (4) analyse multiples, terminal values and normalised cash flow in deriving value from corporate models; and, (5) compute long-run marginal cost for purposes of developing price assumptions in financial models. While the descriptions along with practical exercises of these subjects will hopefully help you to avoid some of the famous pitfalls discussed above, mechanical construction of the best financial models in the world has little direct effect on the recurring human mistakes discussed above. When working through the structure, programming and particularly the analysis of a variety of corporate and project finance issues the hope is that you will place these classic patterns of valuation mistakes somewhere in the back of your brain. Because of the importance of the recurring valuation mistakes, the introduction to various subjects in the four parts of the book will periodically return to these issues.

The four subjects involving the structure and creation of different types of financial models; alternative risk analysis using the models; corporate valuation mechanics to derive multiples and terminal valuation from models; and marginal cost principles for deriving economic assumptions. To describe these topics, this text covers corporate finance models, project finance models and acquisition models. You may be wondering whether the subject is too broad and if some of the intricate issues that arise in different modelling contexts can all be adequately addressed in a single book. The philosophy of discussing different types of models and valuation analyses is that you can learn creative modelling techniques and understand why certain model structures are used through contrasting the different general categories of financial models. Further, while one can make generalisations about the different modelling categories, many transactions and analyses have overlapping aspects of project finance, corporate finance and acquisition finance. An investment may be initially structured using project finance concepts; it may then gain characteristics of a corporate finance analysis as it develops a history and expands into other activities. After the corporation has existed for a few years it may consider acquiring new companies requiring acquisition analysis.

As much of this text is designed to be a practical reference guide on how to structure and build models there are a number of ways to read the book. One way you could read through different chapters without touching an excel sheet. This may not be very exciting and would be something akin to reading a cook book without trying out the recipes. A second way to read the book is to work through one of the many of the accompanying models while you tackle the various issues. More than a two hundred customised exercises with instructions along with template project finance, corporate model templates and acquisition model templates are included on the web site. In addition there are many completed examples that may be the most helpful tools in learning how to most effectively become a truly top notch modeller. These exercises, template models and completed model examples are an integral part of this book. A third way to use this book if you already have experience in modelling is to treat it as a reference manual that where you can selectively look up difficult modelling issues such as modelling a debt service reserve account without any circularity or writing a function to deal with retirements of assets and accelerated depreciation.

Probably the only real way to learn financial modelling is working late at night under a tight deadline under the pressure of a transaction. Real modelling is not a linear process, but involves gathering information, focusing on data that is relevant and coming up with ways to best represent the revenues and earnings of a business given sometimes very limited available information. The process of developing the top line -- revenue from volume sold and capacity -- is, and certainly should generally be, the most time consuming and important part of the model that requires a lot of time and creative thinking. Notwithstanding the non-linearity of the real-world modelling process, outlining the structure of models and presenting real world examples in this chapter can provide a head start for those who have not built models and will eventually have to learn the hard way.

The principal objective of this part of the book is to provide you with practical instructions on how to build a well structured financial model that clearly delineates inputs, effectively presents key value drivers, uses separate modules to organize various components in a logical manner, accurately computes cash flow that is available to different debt and equity investors, and presents results of the analysis that effectively represents risks of the investment. A bit of theoretical discussion of how different types of models can be used to establish value is included, but the main objective is simply to provide details on how to build better models. In discussing the process for building an efficient financial model, this part of the book is organized into the following sections which correspond to general structure of a financial model:

- Model objectives and the general notion of keeping models simple
- Structure and layout of alternative types of models
- Avoiding bad spreadsheet programming practices
- Organizing time periods in a model
- Projecting revenues, expenses and capital expenditures in a working analysis
- Developing free cash flow through computing depreciation expense and working capital

- Programming the debt schedule and incorporating cash flow waterfalls that establish the priority of payments to different capital providers
- Creating the financial statements projected tax payments
- Generating a balance sheet and other auditing tools
- Programming difficult project finance issues associated with sculpting, DSRA, funding and re-financing

Some of the subjects discussed in this chapter such as organizing time periods of the model, using techniques to verify the accuracy of mechanical calculations and computing tax depreciation are not very glamorous. While these topics may not have dramatic effects on valuation, use of good modelling practice can improve the efficiency of the process and allow you to spend more time on the important issue of risk analysis. There are many practitioners who have created models the wrong way for a long time who can attest that a few simple ideas regarding structuring and programming models can dramatically improve the operation of a model and ultimately improve valuation analysis.

Chapter 3: General Model Objectives of Structuring Transactions, Risk Analysis and Valuation and Keeping Models as Simple as You Possibly Can

Financial models have three general objectives that should be placed in the back of your mind before you start writing any excel formulas or developing any assumptions. These are: (1) coming up with the expected value of an investment; (2) assessing the risk of the investment; and (3) developing the financial structure of the investment. Effective assessment of risk is the centrepiece of valuation and the most fundamental reason any financial model is created. Believing that all risks can be avoided in any aspect of your life is dangerous and generally leads to poor judgment and bad decisions. Taking measured risk is a fundamental fact of life and in economic analysis financial models can hopefully help your judgment in accepting risk. Once you have attempted to measure risk, you can see what kind of debt and value correspond to the risks. This leads to the final and aspect of valuation that derives of implied value or cost of capital through measuring debt capacity and/or a set of financial statistics such as P/E ratios.

Given the importance of risk analysis in valuation, one of the two central objectives in building a model of future cash flows is to assess risks in a transaction, whether the transaction is simply purchasing a stock, borrowing money, investing in an airport, acquiring a company or signing a contract. The second general objective of building a financial model corresponds to the inference of risk from debt capacity and structuring of transactions mentioned above. Structuring a transaction using a financial model as a tool may mean sculpting debt repayments in a project financing transaction, sizing the senior debt in a leveraged buyout, developing the share exchange ratios in a merger or simply evaluating the reasonableness of P/E ratios when valuing a stock. Depending on the valuation approach, the analysis may address risks to equity holders, risks to senior debt providers or risks to other parties such as contract counterparties. Finally, even if you are an “excel phoebe” you should be able to understand financial models and make informed decisions about the risk of a security.

After the financial crisis of 2008 some have suggested that risk analysis of complicated investments is simply too difficult and opaque for average investors to understand. Investment bankers had supposedly created dangerous overly-complex products that could not be modelled or analysed. To model risks of these structured investments (so named because they split-up or structure operating cash flows to different investors) financial models had to be created that not only measure operating cash flow, but also who gets the cash flow in what order in alternative states of the world. Modelling the risks of CDO's was famous for being “confusedly elegant” and relying on complex statistics that are all but impossible to interpret. The outputs of fancy statistical analysis was sold as really representing economic behaviour and sophisticated models that measured value at risk and the probability of default gave people a false sense of comfort that they could take risks which in hindsight turned out to be silly. By working through the financial modelling mechanics in this chapter, you should see that valuation errors made because models or studies are incomprehensible are no excuse for poor risk assessment. Building a financial

analysis were one sees which investor receives cash flow in what order and then performs risk analysis even for a toxic collateralized debt obligation is not difficult if you are careful with the structure of the model. Financial modelling is not very complex or mysterious even though financial modellers sometimes seem to be involved in a conspiracy that makes the analysis impossible to understand. Hopefully, the modelling discussion follows Warren Buffet's comment that: "Business schools reward difficult complex behaviour more than simple behaviour, but simple behaviour is more effective."

Some rather complicated modelling techniques are presented in this chapter, but the most important modelling ideas that meet the risk analysis and financial structuring objectives involve relatively simple programming techniques. Later sections of the chapter do work through a few complex modelling issues (cash flow waterfalls, accelerated depreciation, debt defaults, tax loss carryforwards, capitalized interest and sculpting debt). Notwithstanding the importance of programming complex financial concepts in an elegant manner, a fundamental aspect of an effective model remains to keep the analysis as simple as possible. A professional modeller put it like this: "financial models must be as simple as possible, but no simpler."¹ Instead of worrying obsessively about small details in a model, it is generally better to concentrate on assuring that risks of key variables are effectively presented alongside the value statistics.

After the financial crisis, there has arguably been a movement away from elaborate mathematical models back to fundamentals and creation of more simple models. The quote below (from the Financial Times) illustrates the folly of overly complex models used by Moody's in evaluating a certain type of structured debt (a CPDO). The complex model used to establish ratings contained a bug led to major problems in risk assessment²:

A single small error in the computer coding that Moody's used to run its CPDO performance simulation had thrown the results way off. When the error was corrected, the likelihood of CPDO default increased significantly. CPDOs, it turned out, weren't triple-A products at all. Preliminary results suggested the error could have increased the rating by as many as four notches.

In order to manage the discussion of different modelling issues associated with risk analysis and debt structuring, financial models are broadly categorized into three different types for purposes of the discussion – deterministic models, stochastic models and back of the envelop models.

Deterministic Models: Deterministic models are the kind of models most of us are familiar with. Even with all of the methods presented below to make the models transparent and logically structured, these deterministic models can become large and difficult to audit. Risk analysis in deterministic models is generally computed using judgmental assessments about how selected variables can change relative to base case assumptions.

Stochastic Models: Stochastic models build on deterministic models but include probability distributions around key variables. The probability distributions depend on relatively sophisticated mathematical analysis of economic variables and their correlation with one another. (Chapter 3) After the stochastic variables are added to a financial model, one can compute probability distributions associated with key valuation measures such as rate of return or probability of default. For example in analysing a hotel, one could assess the probability distribution of future occupancy rates and convert those to a distribution of rates of return.

Back of the Envelope: Simple back of the envelope models can be more important than the other two model types. These models may involve developing some kind of metric to check whether the complex model results are reasonable or they may involve

¹ Caroline von Schmalensee, FAST Modelling Standards, Coordinator: Version: FAST01a: 03 March 2010
<http://www.FASTstandard.org/>

² FT: When junk was gold (rating agencies and sub-prime), By Sam Jones. Illustrations by Balint Zsako, Financial Times, Published: October 17 2008.

simple statistical checks of the valuation. For example, in valuing a hotel one could calculate the value per room and assure it is reasonable relative to the costs of other similar hotels. Alternatively you may compute the return on investment on a year by year basis and think about whether it is really possible to earn the returns given the competitive structure of the industry. Coming up with effective ways to make simple analysis that checks a model can require more creativity and be more difficult than the other models.

Large deterministic and stochastic models built in excel generally receive the most attention when making valuations while simple back of the envelope models seem to be less and less part of the process. The description of modelling methods in this chapter and the next do address the first two model types: deterministic models and stochastic models without emphasizing the importance of making simple checks of the reasonableness of the result. This however does not in any way mean that back of the envelope models should be considered less essential in the valuation process. In fact, developing simple models – and simple is in no way synonymous with easy -- may be more important than any of the other analyses. Proving a valuation concept with a relatively simple analysis should take place at both the beginning and the end of the analysis.

The importance of back of envelope checks is illustrated by a case where an RFP was used to acquire bids for the purchase of exiting electricity plants. The electricity plants were sold by a company named Central Main Power Company (“CMP”) and the company that “won” the bid by paying \$886 million for the plants was named FPL Energy. The plants being sold were old and consisted of 1,185 MW; the largest plant in the portfolio was an oil fired plant in the U.S. State of Maine named the Wyman plant (594 MW) which had entered service about twenty years earlier. When selling the plants, CMP used an auction process which of course came along with a strict deadline for submitting bids. FPL was able to buy the Wyman Plant by making a bid that was higher than the bids submitted by other companies. FPL most probably used very sophisticated projections of future electricity prices, transmission constraints, and natural gas prices along with a big deterministic financial model in coming up with its bid. As is common in this sort of analysis, the modelling was likely finalized late at night and everyone was probably very tired. In the end, the FPL bid for the old oil plant and the other used plants of \$748/kW was a lot more than the cost of brand new and much more efficient natural gas combined cycle plants which were being constructed at a cost of less than \$600/kW.³ According to rumour, FPL’s sophisticated models contained errors that resulted in the high valuation. A back of the envelope analysis would have developed an approximate valuation by discounting the cost of a new plant to consider age and efficiency factors. Little more than a year after the purchase, FPL took a \$176 million write-off as a result of paying too much for the CMP assets.⁴ In this situation, a much simpler model that adjusted the cost of a new plant for the age and other factors would have been an important check of the sophisticated deterministic or stochastic models.

Chapter 4: The Structure of Alternative Financial Models: Common Features and Differences in Layout of Financial Models for Project Finance, Corporate Finance and Merger and Acquisition Analysis

In developing any deterministic financial model, before you begin to enter data or write any excel formulas or make any valuations, it is essential to think about the architecture of a model. This idea of coming up with the structure virtually any analysis in finance, economics or for that matter science and engineering involves (1) organizing the inputs, (2) understanding mathematical calculations and (3) presenting outputs. The general design of a financial model involves deciding on how to organize the inputs from various information sources in an structured manner; how to formulate the mechanical calculations in a transparent way that is easy to audit and understand; and, finally how to present the outputs so that

³ 2001 FPL SEC 10-K.

⁴ 2001 FPL SEC 10-K, the official reason given by FPL for the write-off was a change in regulations regarding transmission pricing.

purposes of risk assessment and valuation. Other than these basic elements of structuring the inputs, calculations and outputs of a model, subjects that should be considered in laying out the architecture of a model are the programming of time periods, the methods for verifying model accuracy and the setting-up of alternative scenarios. Much of the process in developing an effective model is simply putting things in an order that makes sense and understanding the starting point of the model.

One of the most influential and lasting ideas in finance has been the work of Modigliani and Miller in 1958 who suggested that the focus of valuation should be on aggregate free cash flow that can be distributed to debt, equity any other investors rather than the way the cash flow is split up between alternative investors. If you really still believe the theory developed by Modigliani and Miller that debt and other forms of financing does not make any difference in the way real world investments are made, or that debt does not influence valuation, then you should then stop all of your financial models after computing EBITDA, capital expenditures, working capital changes and taxes on operating earnings (EBITDA, capital expenditures and working capital changes are the components of the typical definition of free cash flow). There is no need to worry much about the financial structure of a model and create an income statement or compute earnings per share, equity cash flow, debt service coverage or a balance sheet. You can only focus on operating cash flow less taxes that must be paid before any money is paid to investors; capital expenditures that must be made to sustain operations; and, working capital changes adjust EBITDA to reflect true cash flow. Although calculating prices, demand, cost structure and the cost of new capital equipment – the drivers of unleveraged free cash flow -- is the most important aspect of any model, almost all of the valuation techniques described later in the book require analysis of items in addition to free cash flow. When financing is explicitly considered, models may concentrate on earnings after interest and/or debt and equity cash flows (after debt service) and/or financial ratios such as Debt/EBITDA that include balance sheet items. Therefore, much of the discussion of financial models in this chapter considers the financial structure of a company or project and the distribution of free cash flow to debt investors, equity investors and income taxes.

The layout and ordering of items in a deterministic financial model to a large extent depends on the type of investment being assessed. Most financial models can be classified into five general categories -- corporate models, project finance models, acquisition models, merger integration and real estate models. Because of different data sources and alternative valuation techniques, the layout of financial models is different for each of these model types. The valuation techniques, data sources and outputs of these models can be summarized as follows:

Corporate Model: The distinguishing feature of the first and most common model type, a corporate model, is that a corporation has a history and it is assumed to last indefinitely (although virtually all companies will either end up in bankruptcy or eventually be purchased.) This means that valuation of a corporation begins with historic analysis and the models must include some kind of terminal value assumption. The terminal value calculation is necessary because it is not reasonable to make detailed forecasts of cash flow item for the indefinite life of the corporation which would require forecasts for fifteen to fifty years into the future. An important item in corporate models is the projection of earnings per share since this is the number evaluated by investment analysts.

Project Finance Model: The second type of model for a project finance transaction differs from a standard corporate model because the investment is characterized by different phases with different risks; the fact that no history on cash flows exists for the investment (no matter how many times a similar new combined cycle plant is built, you don't know how it will work until you switch it on); and the isolation and quantification of particular risks. Rather than spending time on studying history, project finance analysis involves evaluating consulting studies and engineering reports such as traffic studies, price forecasts and marketing analyses. The project finance models focus on cash flows accruing equity holders and lenders rather than earnings and the projections generally cover the entire defined lifetime of the project.

Acquisition Model:	The third type of model, an acquisition or leveraged buyout model, measures the returns earned from an acquisition transaction that involves the consideration paid for the equity of the company, the holding period of the investment and exit price as well as the manner in which the acquisition is financed. To compute equity returns, acquisition models measure the manner in which alternative financing sources are repaid and ultimately compute the return earned by equity investors.
Merger Model:	An integrated consolidation model computes earnings per share and credit quality measures on a standalone and a consolidated basis before and after a merger or acquisition. This type of model considers the specific financing and accounting of the transaction as well as cost savings or synergies generated by the transaction. A common application of this type of model is to evaluate how much can be paid for a company before earnings dilution will occur and bond ratings can be maintained.
Real Estate Model:	A real estate model is a cousin of project finance models but also has many elements of corporate finance analysis. Rather than concentrating on a single investment, a group of multiple investments in a portfolio are often combined together. For example, a mixed development model includes different residential properties with different construction start and finish dates as well as different commercial and even industrial properties. Real estate models must be able to evaluate cash flows that are produced at different time periods without a single construction and operation period. Further the models must be able to quantify the effects of different holding period strategies and alternative tax treatments. Appendix 1 discusses the real estate models in more detail.

Each of the different model types has many principles and programming techniques in common. They each require up front thought as to the structure and the scope of the model; they each require analysis of timing issues; they each should be segregated into components and begin with layout of operating and financing assumptions; they each should have audit and verification procedures; they each should have a starting point; they each should not contain bad programming practices; and they each should be structured so as to facilitate effective risk analysis. However, each model structure contains unique complexities that can make the models difficult to understand, in-flexible, in-accurate, unorganized and un-stable. Differences between the structures of alternative model types are discussed below.

Structure of a Corporate Model to Recount the History of the Company and Make Forecasts that Include Sensible Outlooks of Key Drivers

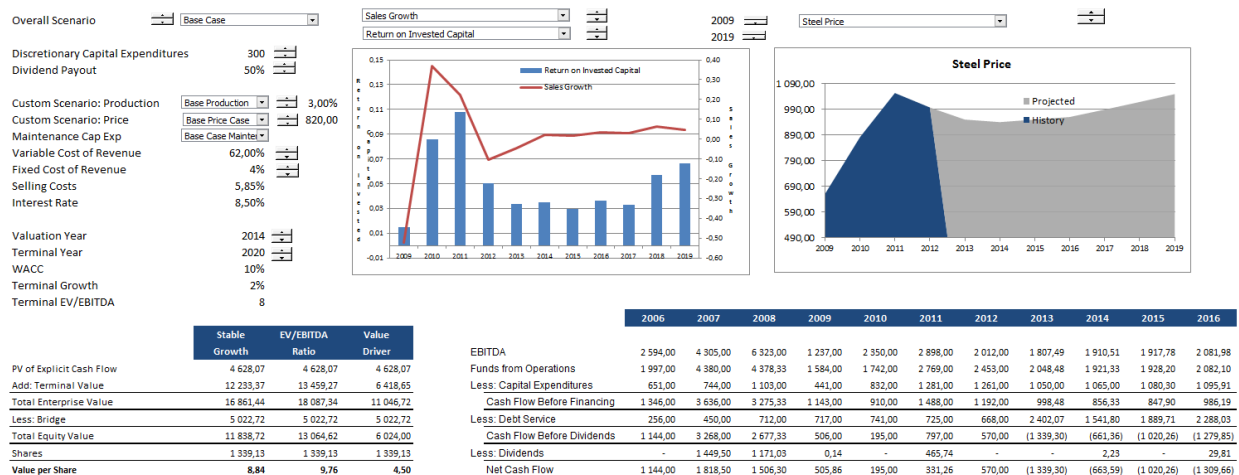
Among other things, forecasts from corporate models are used to compute free for making valuations and to assess the credit quality of a company in the context of providing loans. Valuation from corporate models may use discounted free cash flow, evaluate earnings per share or it could be derived from equity cash flow. Loans may be assessed in a corporate model through gauging the ability to repay debt service from cash flow and/or evaluating the capability of the corporation to repay the loans through re-financing given a set of credit quality indicators such as debt to equity and debt to cash flow ratios.

The structure of a corporate model is directly associated with the idea that a company has a history and an indefinite lifetime (unlike a project finance investment that generally has no historic record and will end once the asset is no longer useful). Whereas a project finance analysis is analogous to a person's life or to a relationship -- both of which have a definite beginning and end -- a corporation is more analogous to a family, a country or city which may have seen better times or may have bright future prospects. The indefinite life of a corporation means that a financial model can only take a snap shot of the company that covers a portion of its history and also that the forecast must stop at some point while the company is still generating cash flows. It is usually impracticable to include all periods of history in the model and it would be silly to try to make a forecast that extends infinitely. But including enough history in a model so that

you can make judgments about exposures to economic downturns and potential volatility in cash flow is an essential part of making a corporate model. When Winston Churchill observed: “The farther backward you can look, the farther forward you can see” he surely was not talking about the structure of a corporate financial model, but the quote is relevant to the structure of a corporate model. Perhaps the most prominent feature that differentiates corporate models from project finance models is incorporation of historic data and the ability to analyse both projected results alongside historic data.

Designing the structure of a model should follow a logical and natural progression beginning with history, moving to assumptions, computing operating cash flows and then adding debt financing. When setting up a corporate model, the structure should allow users of the model to easily make judgments with respect to whether assumptions are reasonable in the context of historical performance. As part of the historic evaluation, it is a good idea to present historic together with projected financial ratios such as return on invested capital, EBITDA margin and credit ratios in order to tell a story about what has happened to the company in the past and what you expect to happen in the future. By presenting financial ratios such as return on investment next to the key assumptions, you and others can quickly see if you made some nonsensical assumptions and your model is less of a black box. In addition to recounting a tale about what happened in the past, financial analysis of history provides a basis for comparing projections with actual results that can be used as a simple check on the reasonableness of a forecast. If the return on investment has consistently hovered between 8% and 10% and your forecast shows a return of 20% you better have a very good and simple explanation about what kind of special thing the company is going to do to earn the higher return.

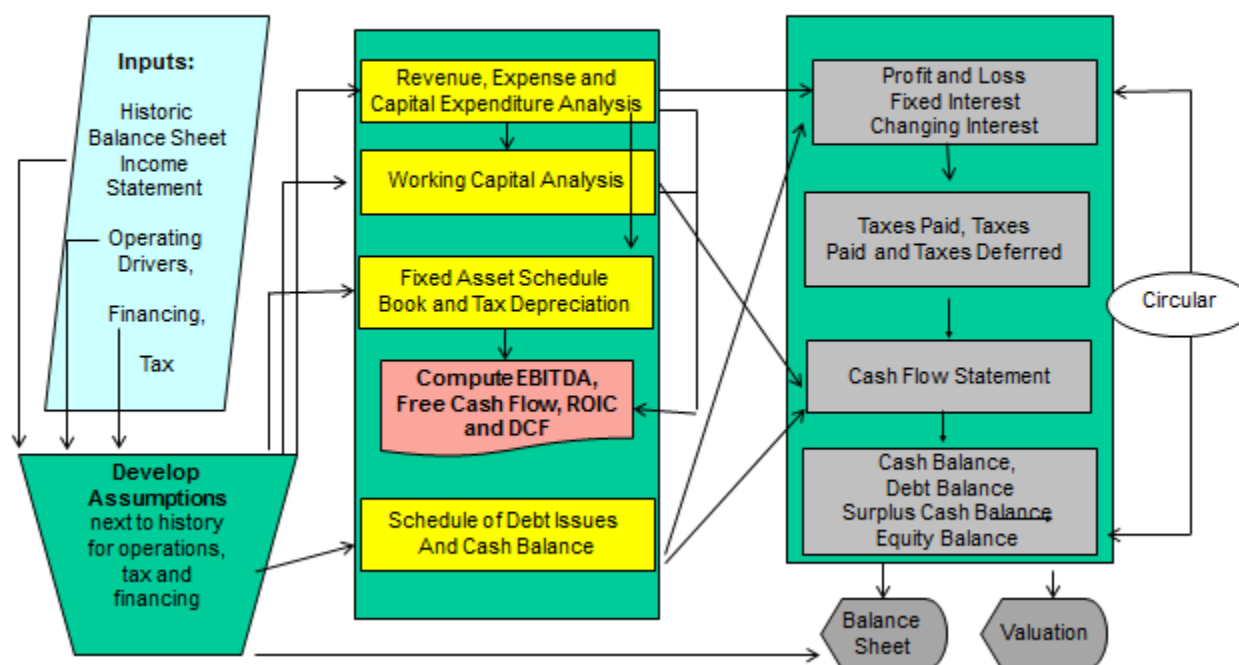
To illustrate how corporate finance analysis is centred on analysis of history and should be a narrative about the company, the excerpt below from the summary page of a corporate model shows how graphs of historic data is connected to assumptions and how the valuation is most effective when it is judged in light of historic and projected financial ratios. There is one graph that shows a couple of financial ratios together (in this case it shows sales growth and return investment corresponding to the fundamental idea of corporate finance theory that when returns exceed the cost of capital, it is good for investors to grow a company). A second graph shows the history and forecast for one of the key assumptions. The drop down boxes allow you to see a wide range of assumptions in the right hand side graph while the graph in the middle of the page shows the historic and projected return on invested capital along with the sales growth. These graphs are shown together with key operating assumptions and a summary of valuation and credit quality indicators.



After painting a picture of the company using historic financial statement analysis, structuring a corporate model involves defining how one incorporates history as well as prospective industry structure and

economic assumptions to assess the value of a business. The mechanical process uses an historic balance sheet items and connects interest expense and interest income in the income statement to the balance sheet debt through evaluating the cash flow. The process of beginning with historic balance sheets and then working through each component of the balance sheet in distinct parts of the model produces a structure which should be transparent and accurate. In a corporate model, two very simple ideas can dramatically improve the structure of the model. The first is understanding that the starting point for all of the fixed asset accounts, debt accounts, working capital accounts, deferred tax accounts, accumulated depreciation accounts, surplus cash accounts, and other items come straight from historic balance sheet. The second is setting up separate accounts for all of these items where historic closing balances come from the historic balance sheet and projected amounts are often directly or indirectly derived from capital expenditure, revenue and expense forecasts. For example, capital expenditures are added to the opening plant balance (and retirements can be deducted from the balance) to yield the closing balance for the next period.

Structure of a Standard Corporate Model



Natural progression of assumption development and working analysis from the income statement and the balance sheet. All the way from the top line revenues to minority interest, earnings per share and dividends. Most of focus should be on the top line and more mechanical as move down the income statement. Each line item should be analysed and some can be aggregated. Similar story for the balance sheet. Most items already evaluated by working through the income statement, but some such as A/R to revenue, provisions, goodwill and so forth must be reflected.

The diagram above is intended to illustrate some of the important points in structuring a corporate model. The process begins with analysis of history and the using historic balance sheets to set-up accounts. The working analysis, the fixed asset balance and the debt schedule are the essential intermediate steps that should be completed before constructing financial statements. Developing revenues, operating expenses and capital expenditures in the working sheets is just about always the most important part of the analysis. When making forecasts of revenues, expenses and capital expenditures it is generally a good idea to graph history and projections of key variables that drive these three things such as prices, market

share, industry demand growth, capacity utilization, variable costs and capital expenditures per unit. Once the operating analysis, depreciation, and debt analysis are complete, financial statements can be constructed. As most of the components of financial statements such as revenues, depreciation and interest expenses have already been in separately structured sections, this part of the analysis should be quite simple.

One of the main computational challenges in a corporate model is to determine how surplus or deficit cash should be deployed and to develop projections of depreciation and deferred taxes that account for the lifetime of different asset classes. The diagram below illustrates that connection of the profit and loss statement with the interest expense and interest income that is a typical characteristic of a corporate model (that can create circularity). The arrow on the right hand side of the diagram is meant to show that interest expense on new debt calculated from the model is not known until the debt balance is computed from the cash flow and interest income on surplus cash is not known until the amount of surplus cash is derived. Unlike project finance models, dividends are determined from an algorithm such as a payout ratio and are not the result of the cash flow process.

The final parts of the diagram show that the balance sheet should be an output of the model rather than part of the mechanical calculations. To construct a projected balance sheet, the common equity balance can be calculated using historic balance sheet data and projections of net income and dividends as with the other balance sheet accounts where an opening balance and changes are included (a similar account can be computed for minority interest.) With all of the accounts completed including the equity balance, the balance sheet can be computed by simply gathering together the closing balance of all of the accounts. Then you can be so very happy to see that your balance sheet is in balance for every single period of the model. Much of the remainder of this chapter is structured to work through each part of the model shown in the diagram above: there is a separate section devoted to discussing economic, financial and modelling issues associated with the input section; the operating or working section; the debt schedule; the profit and loss statement and the cash flow statement.

Some of the computational challenges in corporate models include:

- Development of effective assumptions that include industry supply and demand and conversion of capacity, demand and market share into revenues, expenses and capital expenditures;
- Flexible incorporation of historical financial data to accept updates when new financial data become available;
- Modelling projected depreciation expense with asset retirements, deferred taxes and net operating losses;
- Including target capital structures in the models rather than assuming net cash flow builds up cash balances or accumulates debt; and,
- Dealing with unfunded pensions, derivative assets and liabilities, stock options, intangible assets and other items.

Graphing Data with the INDEX function and the Wiper Method

This book is structured by first discussing conceptual issues associated with financial and economic modelling and then presenting practical spreadsheet methods to implement the ideas. To demonstrate the manner in which analytical methods are presented, the INDEX and the MATCH functions are introduced in this section. For a corporate model, one of the most useful spreadsheet functions is the INDEX function. This function allows development of scenario analysis; it can be used to create graphs of all of the assumptions with dropdown boxes; it permits you to make flexible valuation analysis with different valuation start dates and it is useful for many other things in all types of models.

The INDEX function does nothing other than finding the value of a cell in a given area after defining a row, a column or both a row and a column (it could be called the find function, but the find function is used in working with strings). One of the most effective ways to use the INDEX function is to select an entire

sheet and then provide the row and column number to find a value in the sheet or to select an entire column (row) of data and provide the row (column) number to find a value as shown below:

Value = INDEX(Defined Area, Input Row of Area, Input Column of Area)

Value = INDEX(Entire Sheet -- on upper left, Input Row of Sheet, Input Column of Sheet)

Value = INDEX(Defined Column, Row of Column Area)

Value = INDEX(Entire Column of Sheet -- click on entire column, Row in Sheet)

Value = INDEX(Defined Row, Column of Row Area)

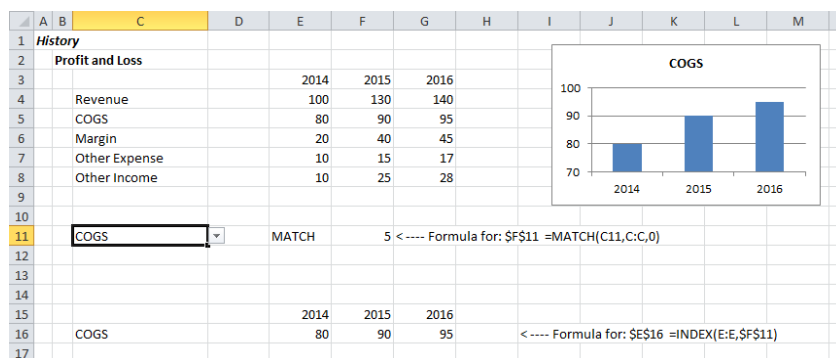
Value = INDEX(Entire Row of Sheet, Column in Sheet)

The way different ratios, assumptions or historic items can be selected for making a graph in a corporate model is to find the row or the column for the item using the MATCH function. Say the word REVENUE is in the fourth row of the sheet as shown in the example below. The MATCH function can give you the number 4 if you enter the formula below:

Row of Sheet = MATCH("REVENUE", Entire Row of Titles, 0)

The MATCH function can also be used to give you the column number and it is not necessary to use the MATCH function with an entire row or an entire column. The zero in the above formula is used as an option that specifies the exact value must be found (this is discussed in more detail below).

Once the Row is defined from the MATCH function, the INDEX function can be used with alternative columns to collect and the fixed row number (using the F4 short-cut key to fix the row number in different columns). In presenting analysis techniques in this book, an excerpt from a spreadsheet is often presented to illustrate how the process works. The excerpt below shows how the MATCH and INDEX functions can be used with the data validation feature in excel to pick alternative variables in a sheet. After the INDEX is defined a graph is created with the ALT and F1 short-cut key. The example demonstrates that the MATCH and the INDEX are brother functions. As you become a spreadsheet wizard, you should show your prowess by stating how you use the MATCH and INDEX functions to differentiate you from an unsophisticated users.



Making the Painful Process of Acquiring Data from a PDF File Easier

When making forecasts in the 1980's you had to ring the company and ask for the annual reports to be sent after which you had to manually type in all of the data. Life is better now but certainly not perfect. You can directly download data from free websites or you can pay a lot of money to Bloomberg for the data but invariably you still need to use some data from the annual report of a company that is not in a nicely structured spreadsheet but instead part of a pdf file. Copying data from a pdf file into excel results in a mess where words are in different cells and numbers are not in consistent columns (sometimes the items are not in different cells which means you should use the text to columns option in the data menu). The data may look something like the format below:

Notes	2008	2007	2006										
ASSETS													
Non-curre assets													
Property, plant and equipment				9,00	\$	9,01	\$	10,11	\$	3,66			
Intangible assets other than goodwill				10,00		885,00		806,00		37,00			
Goodwill	5,00	2,39	2,15	112,00									
Investment in joint ventures and associates						11,00		551,00		592,00	1,49		
Deferred income tax assets				8,00		44,00		22,00		11,00			
Other non-curre assets				13,00		278,00		240,00		272,00			
	13,16	13,91	5,58										
Current assets													
Inventories	14,00	2,42	1,62	864,00									
Trade and other receivable				15,00		1,37		1,80		556,00			
Prepayme	76,00	196,00	82,00										
Loans receivable	108,00	48,00	19,00										
Receivable from related parties				16,00		137,00		60,00		54,00			
Income tax receivable				262,00		86,00		51,00					
Other taxes recoverab				17,00		397,00		351,00		331,00			
Short-term investme	18,00	589,00	25,00	25,00									
Cash and cash equivalen				19,00		930,00		327,00		842,00			
	6,28	4,51	2,82										
Assets of disposal groups classifi ed as held for sale										12,00	7,00	211,00	105,00
	6,29	4,73	2,93										
Total assets	\$		19,45	\$	18,64	\$	8,51						

To format the data you can create a macro to move numbers into a consistent column and then use a function to sum the text into a single cell. Once you run the function and the macro the format is cleaned up as shown below:

	2008	2007	2006
ASSETS			
Non-current assets			
Property, plant and equipment 9	9,012	10,107	3,655
Intangible assets other than goodwill 10	885	806	37
Goodwill 5	2,387	2,145	112
Investments in joint ventures and associates 11	551	592	1,494
Deferred income tax assets 8	44	22	11
Other non-current assets 13	278	240	272
	13,157	13,912	5,581
Current assets			
Inventories 14	2,416	1,619	864
Trade and other receivables 15	1,369	1,802	556
Prepayments	76	196	82
Loans receivable	108	48	19
Receivables from related parties 16	137	60	54
Income tax receivable	262	86	51
Other taxes recoverable 17	397	351	331
Short-term investments 18	589	25	25
Cash and cash equivalents 19	930	327	842
	6,284	4,514	2,824
Assets of disposal groups classifi ed as held for sale 12	7	211	105
	6,291	4,725	2,929
Total assets	19,448	18,637	8,51

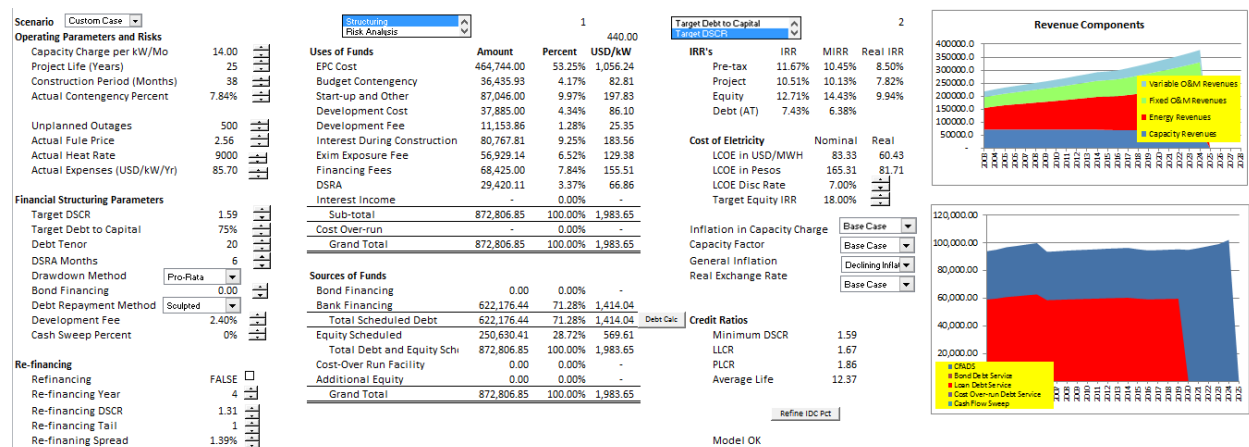
Writing the macro and the function only require a few lines of code using two fundamental concepts. The first is a FOR and NEXT loop and the second is the CELLS command. In the next few chapters these concepts are described in detail and an explanation of the code is included appendix to this chapter.

Structure of a Project Finance Model that Accounts for Different Financing, Risks and Accounting in Different Phases over the Life of a Project

Whereas you can think of corporate finance and corporate models as computing the value of a family (like the Carlene family in the Godfather) you can think of project finance models as representing the value of one person from time the person is conceived until he or she dies. Unlike corporate finance analysis there is no history in project finance analysis as the model starts before the person is born. Instead, the project finance models evaluate risks and returns for different phases in the defined lifetime of a project. The source of data is some kind of contract, consulting report or engineering analysis rather than financial statements. As with a person, risks and value change over the course of a life and eventually the project

becomes worthless near the end. Given that there is no historical record for a project finance corporation called a special purpose vehicle (SPV) and therefore no historic balance sheet, the launching point for projection of financial statements is construction of a sources and uses of funds during the construction phase of a project.

Key financial outputs from project finance model come directly from the cash flow statement rather than the profit and loss statement. The single statistic that has the most importance for project owners is the equity IRR that measures the growth rate in case flows after money has been paid to lenders (debt service). The equity IRR is highly influenced by the amount of debt financing, the method and timing of the debt repayment and the tenor of the debt. Equity IRR also depends on whether and when the project is sold as well as whether and when the debt is re-financed. As the financing structure has such a large effect on the economics of projects, evaluating the economics of a project from the perspective of lenders is an essential part of the modelling. The lender perspective implies that the buffer of cash flow measured to debt service (what percentage is the cash flow above the debt service) that is measured by the debt service coverage ratio and other ratios is a key component of the model. An example of outputs from a project finance model is shown in the diagram below which includes a picture of the project during the construction phase (before the person is born) as shown by the sources and funds analysis. After the commercial operation the picture of the project can be summarised by the cash flow relative to the debt service..

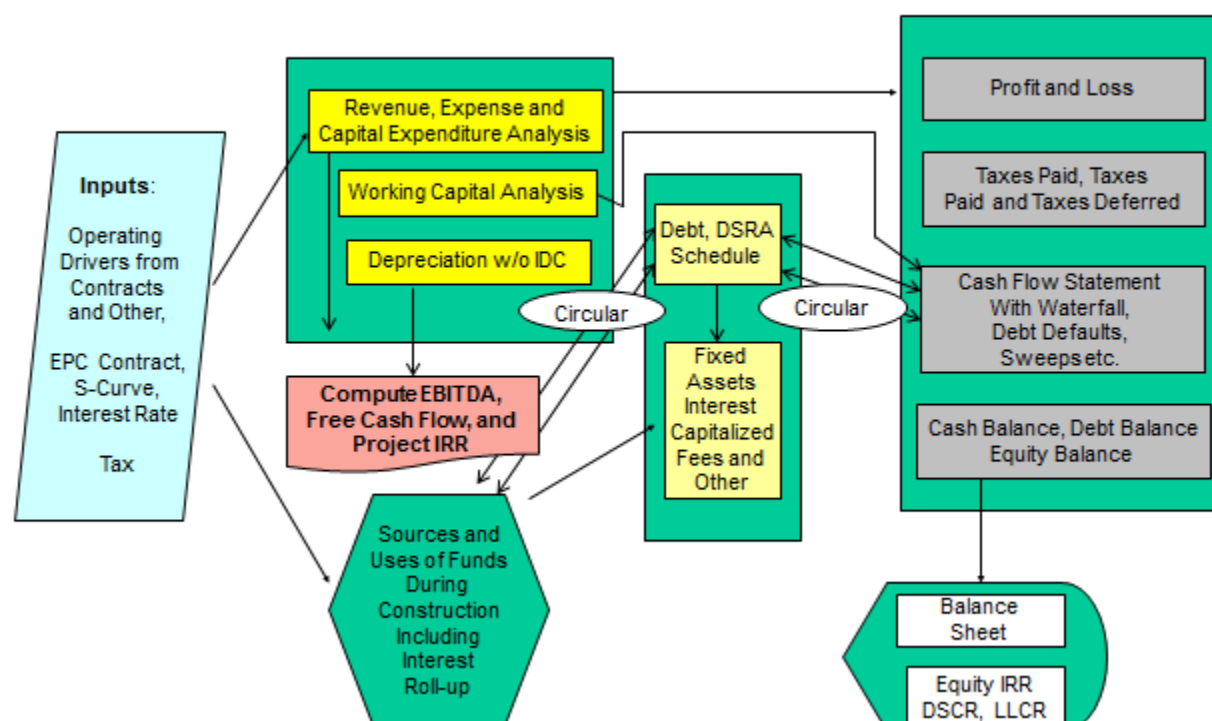


Project finance models typically have two distinct objectives. The first is to structure the debt and equity that will be issued in the transaction including the size of the debt, the tenor of the debt and the manner in which debt will be repaid. The second is to assess specific risks in different time periods of the project life given the defined financial structure. The project finance models should be also be able to assess the effects of different types of re-financing and compute the value of the project over time as the risks change.

The general structure of a project finance model is illustrated on the diagram below (a more detailed structure is described in the last part of the chapter.) One of the essential elements of a project finance model is that different calculations are made for distinct phases of the project – the development phase, the construction phase, the operation phase, the debt repayment phase and possibly a re-financing phase. The sources and uses statement is computed during the development and the construction phase. While the things that go into this part of the model are not complicated to think about – what ones spends money on and how one raises the money – the source and use statement provides a good picture of what the project is about (recall Eurotunnel from Chapter 1). From a mechanical perspective, the sources and uses statement replaces the balance sheet as the starting point for the balance sheet accounts. This is illustrated in the diagram where arrows from the source and use statement launch the fixed asset schedule and the debt schedule. The working module that computes revenues and expenses is similar to the corporate model as is the fixed asset schedule and the debt schedule. Part of the debt schedule is computing the interest during construction that is capitalized to the cost of the plant.

A project finance model can involve complex programming issues regarding (1) setting-up time periods; (2) working out a funding cascade for senior debt, subordinated debt, and equity during construction; (3) modelling the debt service reserve account and the maintenance reserve account; (4) developing a cash flow waterfall that works through cash flow priorities; (5) sculpting debt repayments to meet a debt service coverage constraint, modelling depreciation that depends on calendar years; and, (6) re-financing debt and incorporating cash sweep covenants. The difficult challenge in creating a project finance model is to address these issues without making the model hopelessly complex and cumbersome with many macros and complicated formulas. A separate section at the end of the chapter addresses programming issues to resolve these issues in a painless manner as possible.

Structure of a Project Finance Model

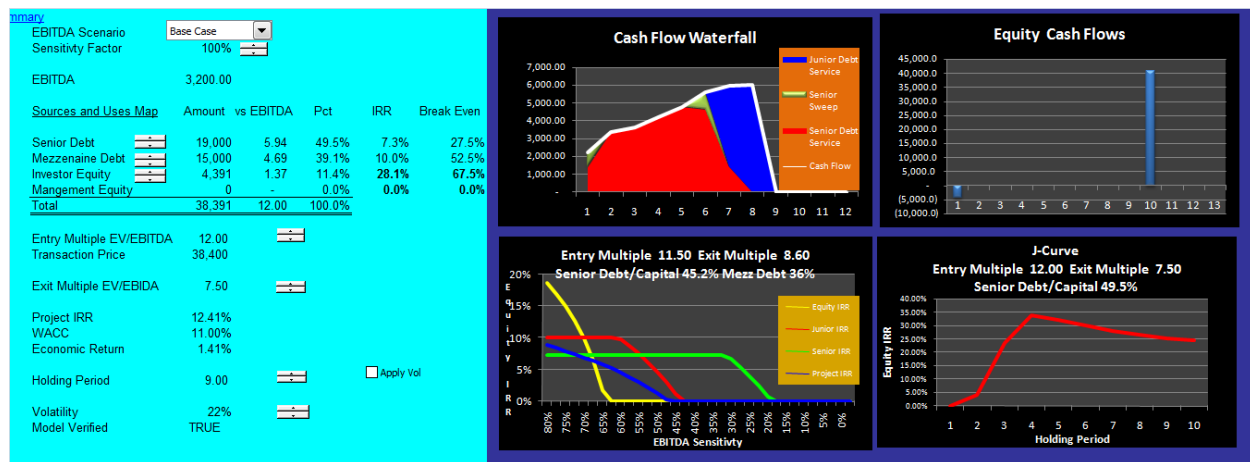


Since a project is generally a one-off investment where debt and equity investors focus on cash flow rather than accounting earnings, the structure for computing cash flow is also different in a project finance model than in a standard corporate model. For a project finance model, the final part of the cash flow waterfall is the dividends paid to the owners of the SPV (sponsors) meaning that dividends are not defined by a dividend payout, dividend per share or some other algorithm, but rather are the residual cash flow not paid or reserved elsewhere. As illustrated in the diagram below, effective modelling of cash flows involves integration of the debt schedule with the cash flow waterfall in the cash flow analysis as well as launching the model from a sources and uses of funds analysis. Risk analysis of a project finance model is also different phases as the construction period typically involves technical risks and the operation period includes economic risks. Finally, as with the corporate model, the balance sheet is part of the output in which all of the accounts such as plant balance, debt service reserves, senior debt balance, subordinated debt balance and common equity balance are already defined.

Structure of an Acquisition Model that Reflects Alternative Transaction Prices and Debt Terms and Evaluates the Return and Risk to Different Providers of Capital

If a project finance model is analogous to simulating your life and a corporate finance model is like representing your family, an acquisition model could be thought of as modelling a dramatic change in the structure of a family -- perhaps moving to a different country; perhaps a marriage that connects the family with another family and changes the structure of the combined family. To make a model of the future prospects of the family after such an event, you could start with the history of the family as with the corporate model. In addition, you adjust the model to reflect to changes that occur because of the new event. An acquisition model is like this. These models may be developed to determine how much to pay for a target company and how much of the purchase price can be financed with different types of financing including amortizing debt, debt with a bullet maturity and debt with capitalizing interest (this is sometime known as "ABC.") Key assumptions in an acquisition model include how much the operating cash flow can grow with new owners and a new strategy as well as the how much the company can be sold for after the holding period. Financial ratios used in assessing an acquisition are often related to the EBITDA. These include the enterprise value (net debt plus equity value) to the EBITDA; the senior debt level to the EBITDA; and the total debt level to the EBITDA. As with a project finance model, an acquisition model can be used for both structuring the amounts of different type of debt as well as risk assessment.

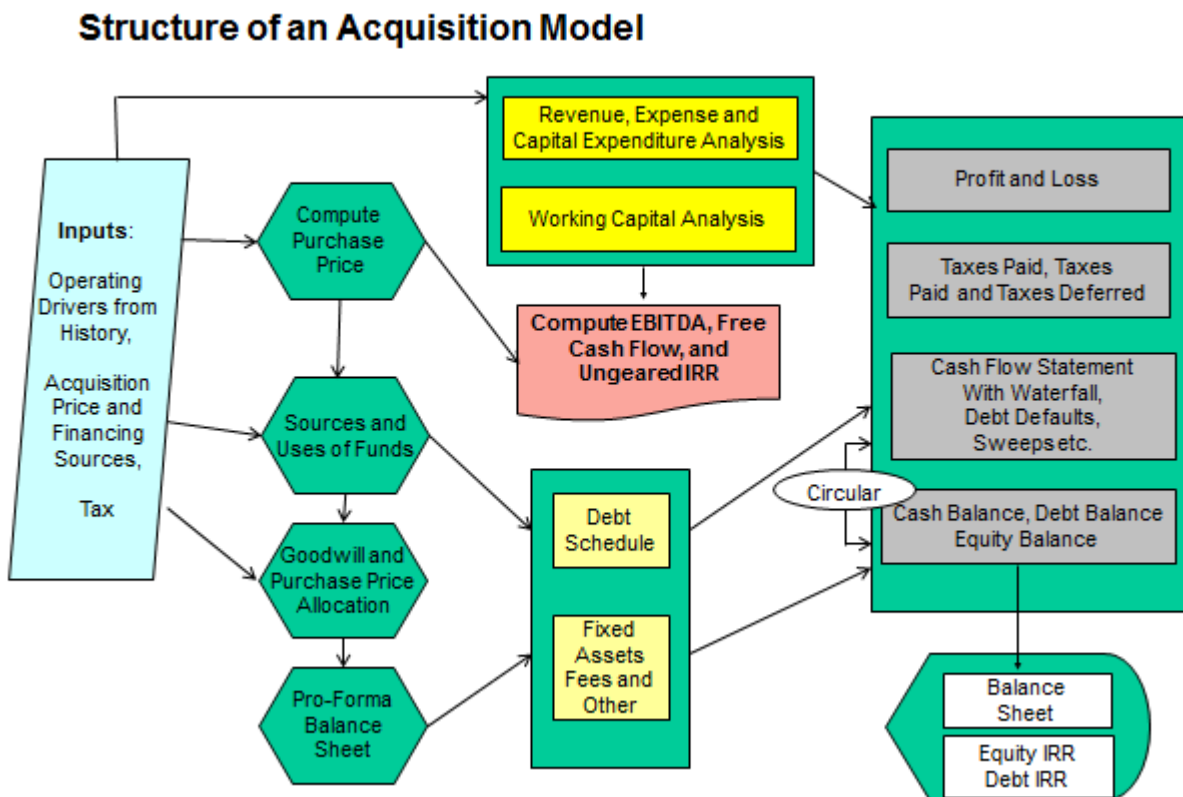
The figure below illustrates output from an acquisition model that could include an illustration of how cash is distributed, break-even points and a J-Curve that illustrates optimal holding periods and equity cash flows that drive the equity IRR.



The structure of an acquisition model is illustrated in the diagram below. The diagram illustrates that modelling an acquisition transaction involves combining some aspects of corporate models and other aspects of project finance models. As with a corporate model, the history of the company is a starting point for painting a picture of the company. However, as with a project finance model, equations in an acquisition model should begin with a sources and uses analysis that shows how much cash is used for the transaction and where the cash comes from. Like in a project finance model, analysing the cash flow priorities is central to the process. After the sources and uses map is established, a goodwill analysis should be added that allows construction of a pro-forma balance sheet.

The general structure of computing a pro-forma balance sheet through mapping the sources and uses of funds along with a goodwill analysis that incorporates the accounting aspects of the transaction is shown in the second column of the diagram. Once the pro-forma balance sheet is created, the modelling process contains similarities to both a corporate model and a project finance model. As with a corporate model that works through different asset and liability accounts on the balance sheet, an acquisition model works through accounts where the first year closing balance comes from the pro-forma balance sheet. As with a project finance model, defining phases in an acquisition model is an important part of the process --the transaction period should be distinguished from the holding period and the terminal period.

The right hand side of the diagram below shows that the cash flow modelling process is analogous to the methods described for a project finance model where a waterfall progression measures the priority of cash flows to the various sources of funds and ultimately the equity holders.



Some of the challenges in creating models that measure the value of an acquisition or a leveraged buyout include:

- Creating a cash flow waterfall with alternative amortizing, bullet and capitalizing debt as well as cash requirements and revolving debt facilities
- Developing a alternative structuring assumptions and a pro-forma balance sheet
- Structuring the cash flow analysis to determine the points at which alternative financing instruments yield returns below the risk free rate
- Simulating alternative purchase prices to yield required returns with different holding periods, exit multiples and holding periods
- Modelling income taxes and alternative tax treatments of transactions
- Simulating the structure of equity cash flows to alternative investors from earn out provisions and equity kickers

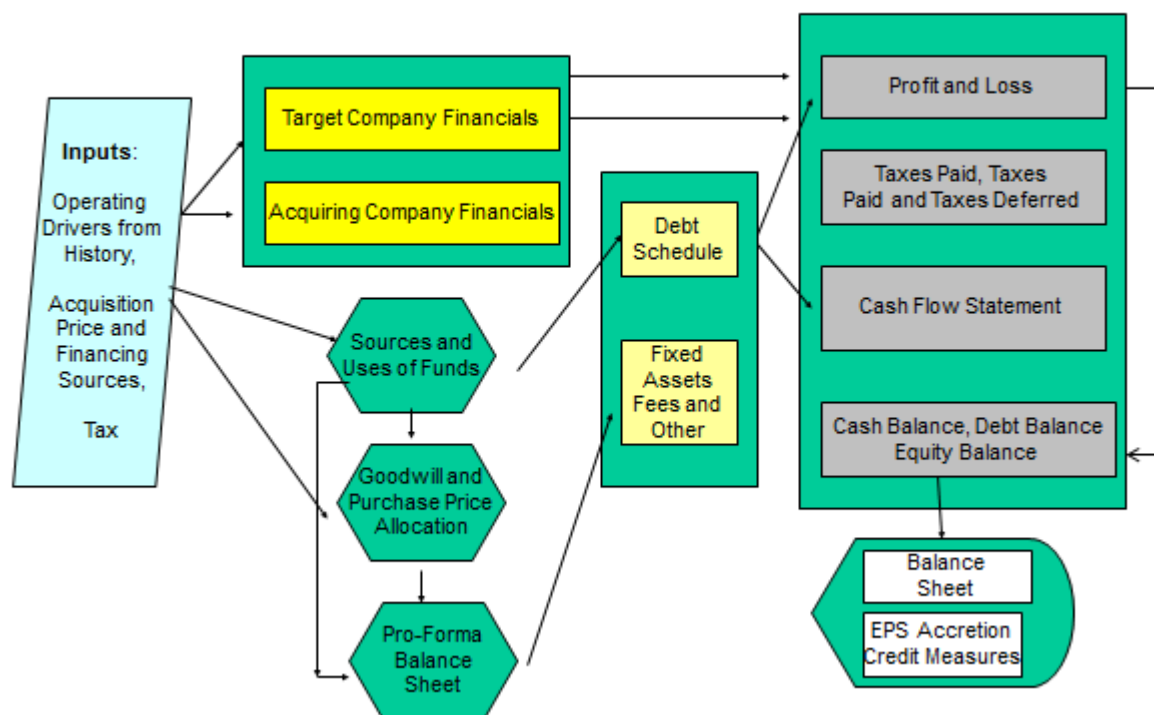
Structure of an Integrated Merger Model that Produces Forecasts of Earnings Per Share Given Different Transaction Structures and Synergy Estimates

The objective of a merger integration model is to evaluate how much to pay for a company and how to structure the financing of a merger transaction. An integrated merger model compares earnings per share and credit statistics in the case where a merger takes place to a scenario without a merger. The prospective earnings of the merged company depend on how much is paid for the acquisition and how

many synergies are generated from changing management as well as the financing of the transaction. When measuring the cost and benefits of a merger using an integrated model, the information base is the historic operations, projected cost savings and/or revenue increases and transaction terms.

The diagram below demonstrates that an integrated model structure mixes elements of an acquisition model and a standard corporate model. As with the leveraged acquisition model, the starting point of a merger integration model is a source and use analysis of the transaction and the pro-forma balance sheet after goodwill and other adjustments. The only difference is that the pro-forma balance sheet begins with existing balance sheets of both the target company and the acquiring company. For an integration model, the transaction assumptions incorporated in the sources and uses analysis may include a share exchange, multiple debt issues and new equity offerings. Once the starting balance sheet established, the remaining calculations of the cash flow process are similar to the corporate model where computation of net cash flow leads to the accumulation of a net cash balance and the net cash balance is separated between short-term debt and surplus cash liquid investments. The debt schedule includes issues retired in the transaction (shown in the sources and uses analysis) and new issues to finance the merger as well as the associated fees and breakage costs. Shares issued in the transaction could come from offering new shares or from the shares issued to target company shareholders as part of a share exchange transaction. The diagram shows that instead of computing a working analysis to derive revenues, expenses and capital expenditures these numbers come from individual corporate models for the target company and the acquiring company. The most difficult item to project is the synergies that arise from management changes that occur with the transaction. In the real world, these synergy projections must be made with only public information and no time.

Structure of an Integrated Consolidation Model



A comparison of the elements that are included in the layout of different types of financial models is shown in the table below.

	Project Finance	Corporate Model	LBO Model	M&A Integration Model
Information Base	Contracts and analysis of Commodity Prices and other value drivers	Historical financial statements; Analysis of value drivers	Historical financial statements; Analysis of value drivers; Transaction Terms	Historical financial statements; Analysis of value drivers; Transaction Terms
Model Starting Point	Sources and Uses Analysis	Historic Balance Sheet	Sources and Uses and Pro-Forma Balance Sheet	Sources and Uses and Pro-Forma Balance Sheet
Cash Flow Process	Cash flow waterfall that ultimately measures dividends paid to equity	Net cash flow after dividends that result in changes in short-term debt or surplus cash	Cash flow waterfall that ends in dividends paid to equity	Cash flow changes that result in changes in short-term debt or surplus cash
Debt Analysis	New Debt Issues from Transaction	New and Existing	New Debt Issues from Transaction	Existing Debt Issues; Retired Debt Issues; New Debt Issues
Model Termination	End of project life	Arbitrary terminal period	Transaction holding period	EPS analysis period
Model Complexities	NOL; cash traps and sweeps; construction period issues; debt service reserves; debt sculpting	NOL; target capital structures; circularity; depreciation vintage	NOL; cash sweeps; interest capitalization on sub debt; debt service reserves; terminal period	Pro-forma balance sheet; minority interest changes; new debt issues
Model Output	Equity IRR; Project IRR; DSCR	DCF Valuation; EPS projection; Implied P/E; Credit Quality	Equity and Debt IRRs; Debt/EBITDA	Project EPS and Other Ratios on Standalone vs Combined Basis

Subsequent sections of this chapter discuss issues in creating each of the major model components. In addition to the general description of what should be included in each section, a discussion of some practical programming tips for those who are involved in construction of models on a regular basis.

Chapter 5: Avoiding Bad Programming Practices and Creating Effective Auditing Processes for Model Verification without Following Unnecessary and Bureaucratic Best Practise Rules

For purposes of valuation and investment analysis, models do not have to be overly complex with thirty different spreadsheets and tedious detail for items that are relatively insignificant. Most people's reaction to receiving a model with many different sheets and excruciating detail of operating expenses is to put the model in a drawer and to not perform risk analysis with the model. Even if valuation models are relatively simple, creating a model that is flexible enough to handle different risks; that accurately measures cash flows; that present the key value drivers and important outputs in an easily understandable and transparent manner; and that does not crash excel because of circular references often requires a disciplined approach to excel programming. A well structured model can avoid the ghastly feeling of, after completing a model, being asked by a supervisor to open and revise a model that was created a few weeks earlier. This feeling often comes from knowing that you will have to review a long and complex formula with multiple "IF" statements that can no longer be interpreted. These types of formulas are generally incomprehensible without completely re-constructing the formula and splitting it up into many different rows.

Some companies require use of a set of “best practices” for programming models. While these practices may help in making models transparent and effective in presenting valuation issues, you can become obsessed with the programming practices and lose sight of the ultimate objective of a model. For example, in order to keep formulas the same across excel columns for the transaction period and subsequent periods, complicated IF statements may be developed that are difficult to interpret. For almost every task in a spreadsheet model there are many different ways to accomplish your objective. Some like range names, others hate them; some like drop down boxes, others don't; some use SUMPRODUCT and some accomplish the same thing with SUMIF. It is best to keep an open mind about different programming issues and generally also best to try to be as lazy as possible with excel functions.

Instead of suggesting there is such a thing as best practice, it is easier to make a list of bad practices that should avoided. Through avoiding the following bad practices a model easier to interpret and modify are presented below:

- ❖ There should be no inputs in any part of the model other than the input page. One of the worst and most obvious problems is to include inputs as part of a formula (e.g.A11*5); these partial inputs are difficult to find and make the models inflexible.
- ❖ Keep formulas in the model as simple as possible and clearly delineate how each formula is derived from the inputs (this is often a problem with long “if” statements). Long formulas can be avoided by splitting formulas into multiple different rows and by using TRUE/FALSE switches. Do not use nested IF statements. Ever. This does not mean that you should follow the silly rule of thumb were formulas are not longer than your thumb (unless you have a very long thumb). But long formulas are the worst practice of all.
- ❖ Make sure that spreadsheet columns are consistent throughout the model and that the formulas for each column are identical (with the possible exception of the very first period in corporate models and acquisition models.)
- ❖ Include the units (such as tons or thousands of Euros) for each column of the inputs and the working sheet.
- ❖ Carefully specify the time period of the model using time period codes that define alternative phases of the analysis. Use the LOOKUP or MATCH and INDEX functions rather than the VLOOKUP or HLOOKUP function to associate inputs with the time period so users can add rows or columns to the model without worrying about different results.
- ❖ Divide the model into separate modules, beginning with input modules and make the inputs a separate colour (the word module simply refers to a separate part of the model -- it could be a separate spreadsheet page or simply a segment of one sheet.) When entering inputs in one or more modules, operating inputs should be separated from financial inputs.
- ❖ Include separate modules for debt issues, fixed plant assets, working capital and cash balances. The debt module should include the interest rates, interest expenses, repayment mechanics, pre-payment possibilities, financing fees and potential for default. The fixed plant asset schedule should include calculation of book and tax depreciation.
- ❖ Work through every single balance sheet item showing the opening balance, additions and subtractions from the account and the closing balance for each the accounts. This analysis should be made for everything single title in the balance sheet ranging from cash accounts to common equity.
- ❖ Limit or avoid the use of macros and iterations to resolve circular references as circular references are not present in the real world and fixing circularity makes many risk analysis programming techniques more difficult.

- ❖ Use the balance sheet and other items as auditing tools and include a separate “integrity” page of the model to present verification checks. The verification should point to the location of the model errors so you do not have to look around the model to find problems. Include a “dashboard” at the top of each page of the model to monitor the integrity and key outputs of the model.
- ❖ Assure that no formulas in the output module of a model affect anything in any other section of the model. This means that you should be able to delete the output section without causing any reference errors in the mechanical calculation parts of the model.
- ❖ Test various balances such as the debt balance, the net asset balance, the reserve balance and other items relative to the opening balance using the MIN function instead of IF statements. The MIN function together with the opening balance puts a cap on things that can lead to negative balances. For example, the scheduled debt repayment can be capped at the opening balance – you do not want to pay more than the existing balance back to the bank.
- ❖ Use the positive number convention which means that individual items are shown in the model as positive numbers and subtotals are explicitly shown as additions or subtractions. For example, capital expenditures are listed as positive in the cash flow statement with the caption “less: capital expenditures” and cash flow after capital expenditures subtracts the capital expenditures.

The above principals seem obvious when written down in a book. However, in the midst of creating a model to meet a deadline, it is very easy to ignore these principals as they seem to slow you down when working under a tight deadline. Examples of bad practices include entering input data in the fifth sheet of a model; including complicated revenue and expense calculations with long if statements directly in the income statement; forcing the balance sheet to balance using some kind of a cash balancing item; computing interest expense without separately listing debt issues and being consistent with time periods.

The single worst practice that is often made by otherwise very good modellers is to make formulas that are far too long. An example of a formula (for projected prices) that is not transparent and almost impossible to verify (taken from an actual model) is shown below:

```
=IF(AB5<14,IF(AB2=6,AA39*(1+inflation),AA39),IF(AB5=14,'OperatingInputs'!$E$103/'OperatingInputs'!$E$104,IF(LEN(AB5)=2,AA39,AA39*(1+inflation))))
```

This formula, contains a number of bad practices. One problem is that fixed numbers are included in the formula (i.e. the number 14 and the number 6.) The larger problem is that the formula is far too complex to easily verify and audit. This formula could be vastly improved if one would split it up into a number of separate rows where one would show the inflation rate in a separate row, the tests in separate rows and the alternative results of different conditions in various rows. If you would be asked to review somebody else's model, it is a good idea to split up formulas like this one. This formula took about fifteen rows and once the more transparent separate rows were presented, several obvious errors were apparent.

How to Make Financial Modelling More Efficient and Accurate

The paragraphs below highlight a few programming techniques that implement some of the concepts listed above so that your model does not become a complete mess. If you are more interested in general modelling concepts rather than the implementation details or you want to be able to read models but not to program them, you should skip the detailed discussion of practical programming and begin reading the next section on time periods and valuation.

Creating Short-cut keys and Setting-up the Model Area so you can build your Model Really Fast

This seems like a trivial little detail, but in structuring a model you can make it much easier to read – the transparency objective – by doing a few things before you start typing a single number in the sheet. Models generally are presented in a similar manner to financial statements from annual reports where

time (years, quarters or months) is shown across columns and items such as revenues listed on different rows. In setting up the columns, it is nice to include some thin columns at the beginning of the sheet so that you can press the CNTL, UP and the CNTL, DOWN keys and move from section to section. The time line section will often be the first section followed by the assumptions section, the operations section and the depreciation section. By putting headings in the first column (e.g. the word timeline, assumptions, operations etc.), you can move from section to section. In most type of models it is also good to leave a few blank columns after you type in titles and to the left of the model equations. In these columns after the account names you can list the inputs, transfer inputs that drive the equations and you can incorporate checks of various items. This is part of the process of being transparent where a reader can hopefully visualise how the equations are working as shown in the example below.

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3. Use the SHIFT, ALT, → combination to group the remaining the selected columns.
4. Press the Number 1 in the square box at the top left of the sheet.

If you need the columns to the right, you can press the number two button instead of the number one key. Results of the grouping approach are shown on the diagram in the next section where the right part of the sheet after the columns have been grouped is grey.

Short-cuts are pretty cool, but it is even more useful to make your own short-cuts. When making your own short-cut you can create a macro around the thing you want to repeat. When creating a macro, you can create a short-cut key as illustrated in the next section, but if you select to make the macro run with CNTL and c, then the copy function will no longer work. Instead, you can create the macro with CNTL and capital C so that it works with SHIFT, CNTL C. When creating your own short-cut to do something like format cells with two decimal places (unlike the SHIFT, CNTL, 5 key which does not include decimals) you can do the following:

Step 1: Go to the cell that you will format with a percent sign and two decimals. You must be on the cell because you should not move the cell as part of the macro process.

Step 2: Record a macro and define a short-cut key with the SHIFT keyboard key. For example, press the capital D for decimals. Do not move the cursor after you begin recording the macro.

Step 3: Change the formatting in the cell (you could use the CNTL and 1 short-cut).

Step 4: Stop recording the macro without moving the cursor.

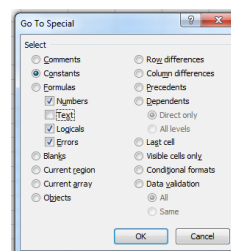
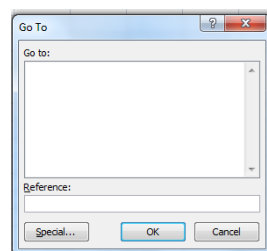
A short-cut key that avoids the irritating excel feature that automatically switches inputs to percentages can be made with the simple macro shown below.

```
' Keyboard Shortcut: Ctrl+Shift+P
```

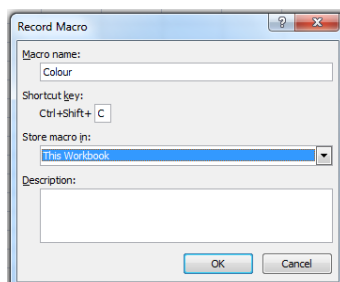
```
ActiveCell = ActiveCell * 100  
Selection.NumberFormat = "#,##0.00"
```

Colour Conventions and Creating the SHIFT, CNTL C Macro to Colour Inputs

In a well structured financial model, colours should be used as a guide to what is happening in various cells of the model. This means the colours should not be used to make the model into an attractive piece of art, but it is better that they provide readers of the model with a quick understanding of where the numbers in a cell come from. One principle is that input cells should be collared differently from other cells, generally through using the fill colour and the background colour. There are few methods to colour inputs. A simple method is to use the F5 key and then the press the special key. Then select the Constants option and find all of the inputs. After finding the inputs, simply select the selected foreground colour.



When using the F5 and the paste special, you can create the process in a macro and redo the process every time that you make a change. When creating the macro you can assign the macro to a CNTL key and use then have your own short-cut key such as SHIFT, CNTL, C to re-do the colours at any time. You can create similar short-cut keys to format your spreadsheet. For example, if you want to format a percentage you can press CNTL,% (SHIFT, CNTL, 5), However this short-cut key does not present decimals. If you want to show decimals, go to a cell that you want to format (this is important) and then start recording a macro. When creating the macro, press the SHIFT B or some other letter and change the number of decimals. Then simply stop recording the macro. The picture below shows how to begin recording the macro.



A second principle is that a different font colour should be used for cells in which data comes from another sheet. For example, if price data is transferred from the input sheet to the workings sheet, that cell should have a colour to notify users in what sheet they can quickly find the source of the data. A macro that sets the font colour of a cell from the tab colour of the sheet included with the materials. Other colours can be used for cells that have been computed from the goal seek or the solver and for cells that are computed through the operation of a macro. Finally, cells in which calculations are made from information in the same sheet should not have a font or a fill colour.

The excerpt at the beginning of this section illustrates a few of the set-up ideas discussed above. The sheet (from an integrated consolidation model) is set-up using the SHIFT, ALT, → method to limit the size of the sheet with the grouping method (when you press 1 at the top left, the columns are hidden, while when the number 2 is pressed, the columns are unhidden.) The red cells come from the target company financials which has a red tab colour while the blue cells come from the acquirer sheet that has a blue tab colour. Finally, the example illustrates that it is a good idea to make a few small columns on the left of the spreadsheet so that it is clear what rows are sub-totals and headings.

Useful Functions in Setting-up a Sheet

When setting-up a sheet it is useful to add a couple of functions in addition to your customised short-cut keys. You can create your own function which contrasts to making a macro. When you make a function you can read in a variable and create a result. When you are in the excel sheet, your function works like the any other function such as the SUM function where you use an equal sign and put something inside the parenthesis. When creating a function rather than a standard macro in excel, there are a couple of basic concepts:

1. The name of the function must be defined as a variable somewhere in the code.
2. Any value that is used from the excel sheet must be read into the function.

One function that is useful is to show formulas in the sheet adjacent the cell where the calculation is made. The excerpt used in the MATCH and INDEX discussion includes this function. To enter the function, you should go to the visual basic (you can press ALT and F11). Then you can type in a function as illustrated below. A simple version of the function names show_form and a little fancier version named show_formula is illustrated below. Note that you must start the code with the name FUNCTION rather than SUB.

```
Function show_form(cell)
show_form = cell.Formula
End Function
```

```
Function show_formula(cell)
show_formula = "< ---- Formula for: " & cell.Address & " " & cell.Formula
End Function
```

It is also useful when setting up a sheet to create a function for showing the sheet name as a formula in the excel sheet. This function requires only one line of code as demonstrated below.

```
Function name_sheet(cell)

name_sheet = cell.Parent.Name

End Function
```

After entering this function, you can type =name_sheet(cell) in any cell and refer to the current sheet or another sheet and find the sheet name.

Use of TRUE and FALSE Switches and Creating a Model Integrity Page so that Excel Tells you Where your Problems are and you do not have to Continually Check Various Different Sheets in Your Model

Part of an efficient model design is creating a method where the program itself presents things that do not work – this is the accurate criteria. It is best to come up with a message somewhere at the top of each sheet that documents the location of problems with the sheet so you do not have to continually look around the spreadsheet. A useful technique is placing a “dashboard” on each page of the model that shows key outputs, inputs and sensitivity analysis switches. In addition, the dashboard on each page should show an overall check on the integrity of the model – does the balance sheet balance, is the debt balance positive, are the dividends non-negative, do the sources of cash equal the uses of cash and so forth. Sometimes it is useful to include a series of audit checks as to whether debt is in default as well as mechanical checks.

An effective way to set up the integrity check of a model is to use TRUE and FALSE logical variables created in excel in various different ways. The use of TRUE and FALSE switches is helpful in many parts of the model. For example, use of TRUE/FALSE variables eliminates the need for painful nested IF statements that can be very difficult to audit and the variables can be used to test covenants and run the model in different modes of operation. A TRUE/FALSE variable can be created by simply using an equal sign (for example, =1=1 is TRUE). It is often useful to apply the AND function together with a series of logical variables to test if the overall value is TRUE (for example AND(1=1,2=2) is TRUE.) Further, when IF statements are used, they can be used with the TRUE/FALSE in the logical section of the statement. The following step by step process illustrates how to create a verification page:

- Step 1: After computing the balance sheet, subtract the assets from liabilities on a separate line. Create similar calculations for the debt balance, the sources and uses of funds and other items. Creating a good test can be a creative process.
- Step 2: In a separate row, use a TRUE/FALSE logical variable (created by setting one cell equal to another) to test whether the difference, after rounding, is equal to zero. (The rounding is necessary because the difference is often not precisely equal to zero if, for example, there is a division by three somewhere in the model). The formula is

=ROUND(difference,3) = 0.

Step 3: Once such the TRUE/FALSE result is established for each period, the AND function can be used to test whether the balance sheet balances in every single one of the periods. The AND function is used on a range of TRUE/FALSE logical variables and placed to the left or the right of all of the year by year tests as illustrated below.

The figure below illustrates the verification of the balance sheet that feeds into an aggregate balance sheet test. The row labelled “test” uses a switch and the ROUND function to make sure the balance sheet balances in each period. If all of the tests are TRUE, then the aggregate test computed with the AND function is also TRUE.

	8-Sep-08	31-Dec-08	31-Dec-09	31-Dec-10	31-Dec-11	31-Dec-12	31-Dec-13	31-Dec-14
Balance Sheet								
Plant Assets	990.00	1,030.00	1,071.60	1,114.86	1,159.86	1,206.65	1,255.32	1,305.93
Less: Acc Depreciation	-	15.40	66.90	120.48	176.22	234.22	294.55	357.31
Net Plant	990.00	1,014.60	1,004.70	994.38	983.64	972.44	960.77	948.62
Senior Debt	306.90	222.51	140.33	41.04	-	-	-	-
Mezz Debt	336.60	369.92	406.55	446.79	348.01	165.50	-	-
Equity	346.50	422.16	457.83	506.55	635.63	806.94	960.77	948.62
Total	990.00	1,014.60	1,004.70	994.38	983.64	972.44	960.77	948.62
Difference	-	-	-	-	-	-	-	-
Test	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Aggregate	TRUE							

Step 4: Link the TRUE/FALSE result from the AND statement to a page of the model that contains other verification checks (for example, in a project finance model or an acquisition model, check whether the sources of funds equal the uses of funds.)

Step 5: Create a separate verification page that combines the balance sheet test with other tests (again using the =AND function) to develop a test for the overall integrity of the model.

Step 6: Identify the sections of the model that have problems using an if statement that uses the title of the test and the result of the test. The if statement has the form:

IF(test, "", title)

For example, when applying the balance sheet test, the test in the above formula would be the aggregate TRUE/FALSE test from the model. The title would be something like “Balance Sheet Test”.

Step 7: Once the sections of the model with problems are identified, make an aggregate presentation of all of the problems in the model. This cell can then be placed in each sheet and each sensitivity analysis to allow you to find problems without looking around the model each time. The aggregate presentation has the form:

=problem1&problem2&.....&problem10

In this equation the problem1, problem2 cells come from step 6 above. The “&” function allows the text to be put together (as if you were adding things.) For better presentation, it is a good idea to put a space before each title so the problems are delineated. You can also create your own function add the text together which is illustrated below. To write your own function simply go to a macro and type the text below existing code.

```
Function add_text(series)

For i = 1 To series.Count
    add_text = add_text & " " & series(i)
Next i

End Function
```

An example of a page that shows verification checks is illustrated in the figure below.

Check Title	Test	Problem Identification	Formula
Sources and Uses	TRUE		=IF(E3,"",D3)
Non Zero Debt Balance	TRUE		=IF(E4,"",D4)
Dividend	TRUE		=IF(E5,"",D5)
Debt Percent > 100	TRUE		=IF(E6,"",D6)
Target DSCR <> Actual DSCR	FALSE	Target DSCR <> Actual DSCR	=IF(E7,"",D7)
Leverage More than 100%	TRUE		=IF(E8,"",D8)
Negative CADS	TRUE		=IF(E9,"",D9)
Fixed Debt Service = Applied	FALSE	Fixed Debt Service = Applied	=IF(E10,"",D10)
Balance Sheet	TRUE		=IF(E11,"",D11)
Aggregate Test	FALSE	Target DSCR <> Actual DSCR Fixed Debt Service = Applied	=F3&F4&F5&F6&F7&F8&F11&F9&F10
Dashboard Presentation ---->		Target DSCR <> Actual DSCR Fixed Debt Service = Applied	=IF(F13="", "Model Ok", F13)

Step 8: Place the final aggregate presentation of problems with the model in the dashboard that monitors each page of the model.

Chapter 6: Putting the Most Important Item in a Model – the Assumptions – through Creating Flexible Inputs, Making Effective Analysis of the Top Line, Cash Operating Expenses and Capital Expenditures

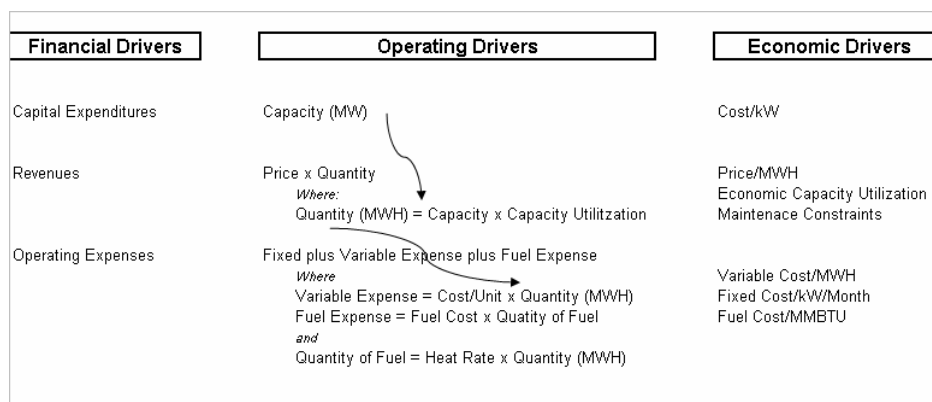
In discussing the structure of various models above (using different diagrams for the corporate model, project finance model, acquisition model and integrated model) each financial model had a lot in common. For example, each model began with an input section and model ended with a balance sheet. Each model includes a working section that computes revenues, expenses and capital expenditures; each model type has a debt schedule; each model includes a depreciation section and each model contains an income statement and a cash flow analysis. These components of models that are common to the different models are discussed in the next few chapters. This chapter begins the discussion of common model elements through describing model inputs and the initial section of the model that should compute revenues, operating expenses and capital expenditures.

Concentrating on the True Value Drivers in Financial Analysis; Demand Driven Models versus Supply Driven Models and the Danger of Overcapacity in an Industry

The most important part of the modelling process is to accurately define and analyse input items that drive the value of an investment and effectively present how the risks of the value drivers affect the ultimate value. Value drivers can be economic variables such as industry demand, behaviour of competitors, price, cost of capital expenditures per unit and the fixed and variable cost structure of investments that determine the level of three items that are the key to any model – revenues, operating cost and capital expenditures. The things that really drive value and should be primary inputs to a model are generally not items such as revenue growth, operating margins, return on investment or the ratio of capital expenditures to sales (although for very large corporations it may be necessary to use these kind

of inputs.) The art of modelling involves identifying how changes in the industry structure from capacity additions and demand changes, technology changes, consumer tastes, product life cycles and other factors affect these value drivers. Modelling and valuation mistakes introduced in Chapter 1 were not due to incorrectly structuring a model or having a financial model that was too simple; they were generally the result of not using valid economic and financial principles in developing industry demand, supply and price inputs to the valuation process. Subsequent parts of the book deal with how to develop inputs for prices, demand growth, cost structure, discount rates and other inputs in capital intensive industries. These inputs can be studied by reviewing historic data, performing statistical analysis, applying marginal cost concepts, and considering industry structure. In addition the value drivers should use judgment as to whether sudden non-linear changes can occur, industry expertise and perhaps mathematical simulation.

When developing a model one can distinguish between whether profits and cash flow of a company are primarily driven by demand and market share or alternatively whether financial results are driven commodity prices and cost management. The former type of model can be referred to as a demand driven model while the latter can be called a supply driven model. The starting point for the assumptions should generally be the capacity of the company (reserves of oil, megawatts of electricity) in a supply driven model. On the other hand, the starting assumption is the industry-wide demand for the product in a demand driven model. To demonstrate the difference between demand and supply driven models consider an upstream oil project. The most likely place to begin the upstream model is with the capacity of the oil fields in terms of oil and gas reserves meaning the model would be supply-driven. You would probably not begin with an analysis of the worldwide demand for oil because oil prices the company operates in a commodity business and it will most probably sell whatever it can produce. Alternatively, for a company operating in a limited market region that may have market power, the model would begin with demand for the product in the industry and market share of the company. The diagram below illustrates modelling of an electricity plant for a supply driven models. The drivers for capital expenditures, revenues and operating expenses are all determined by the capacity of the plant. Economic drivers of revenue, operating expense and capital expenditures include the cost per unit of building the plant, future trends and volatility in prices, the capacity utilization of the plant; and, the variable and fixed costs of operating the plant. The entire subject in Part 4 addresses how to assess value drivers associated with prices and utilization rates.



The most common form of corporate and acquisition models are demand driven models where the starting point should be evaluation of industry supply, demand and prices. Case studies in Chapter 1 demonstrated that many valuation mistakes are made when over-supply occurs in an industry often because demand does not increase as expected or high returns prompt excessive new supply. The famous quadrant diagram of return versus cost of capital and growth can be an effective way to think about assumptions in a model. The top right quadrant called powerhouse companies is where companies are growing fast and earning high returns. Unless really strong competitive advantages exist, other firms from over the world will want to enter businesses represented by this quadrant resulting in surplus capacity. When surplus capacity exists in an industry, prices can dramatically move from levels that support high returns on investment all the way down to the short-run marginal cost of production as companies fiercely fight for market share. In thinking about how surplus capacity can arise, the return on

investment for firms in an industry along with barriers to entry can be evaluated. If returns are relatively high and entry of new firms is not limited, surplus capacity can come quickly. A recent example of such a phenomenon is the solar manufacturing industry where high market valuation and strong returns encouraged addition of new capacity. The new capacity led to dramatic price reductions and declines in market value.

Creating a Flexible Structure of Inputs that Allows Changing Dates, Multiple Scenarios, Variables that Change over Time and Portfolios of Assets

Mechanically, inputs should be on the same spreadsheet page (or set of pages) and the relevant input categories should be grouped together. Generally, the inputs should begin with timing parameters discussed in the last chapter followed by operating inputs, financing inputs and valuation parameters. Inputs can be structured on a period by period basis across a spreadsheet page or they can be entered in alternative time increments where users can insert added time periods with alternative values as illustrated below. In a corporate model, the inputs are often entered next to historic values and it may be convenient to use conditional formatting to illustrate the history in a different colour next to the forecast. Even if models are computed on a monthly or quarterly basis it is often useful to enter inputs in annual terms. Often, inputs should be coordinated with a master scenario page in which case many of the inputs come from a control page.

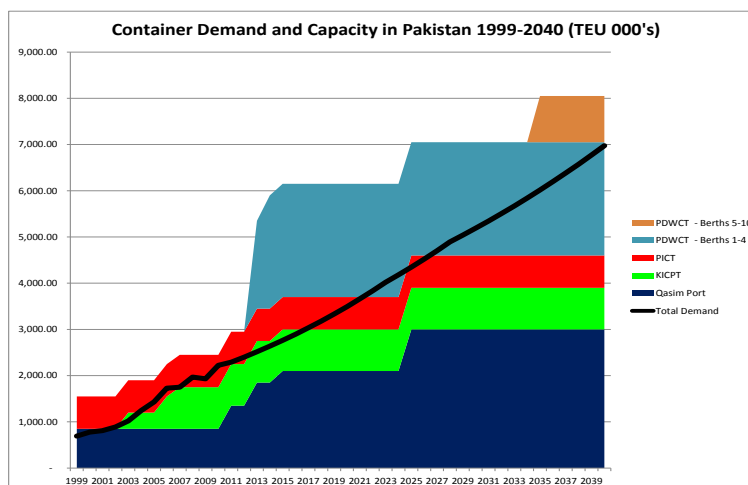
The inputs should be set-up in a way that anybody can easily find the inputs and understand exactly what each input means. For example, a model has an input labelled “development percent” may be confusing because one has no idea what is the basis for the percentage. Inputs should allow the model to be adjusted and not be restrictive. For example, when there is one inflation rate applicable to all future years, the model has limited flexibility. Third, the inputs should be arranged in a logical manner and grouped together by categories that reflect the structure of any model. Assumption sections should include:

1. Timing assumptions corresponding to the different types of models. In project finance models, the key timing parameter is the financial close date, the commercial date, the debt repayment date and the decommissioning date.
2. Capital expenditure assumptions that enable a company to grow including the quantity of products generated from the capital expenditures and the cost per unit of the capital expenditures.
3. Revenue assumptions that include the quantity sold and the price where the price can depend on industry capacity and supply analysis described below.
4. Cost assumptions that are separated between fixed and variable cost so that different sales quantity assumptions can be evaluated and the model can measure risks arising from operating leverage.

The above four assumption categories determine the pre-tax return on invested capital in a corporate analysis and the pre-tax internal rate of return in a project finance analysis. These two ratios define the value of the assets of an enterprise. Remaining assumptions are used to derive the after tax return and the return after gearing including the return on equity and the equity IRR.

5. Tax and associated depreciation assumptions including tax rates, depreciation rates and the difficult issue of retirements in a corporate model.
6. Financing assumptions that include the amount of debt issued, the manner in which debt will be repaid, the interest and fees incurred on the debt while it is outstanding and features of the debt such as covenants and reserves that are designed to protect lenders.

One approach to analyse assumptions is to set-up inputs where a model that begins with industry demand and supply as illustrated on the graph below where the capacity additions planned by different companies (the coloured area) are compared to demand demonstrating the potential for overcapacity. Even if inputs for the industry demand and supply cannot be precisely obtained, the idea of understanding projected supply and demand conditions relative to historic levels is an essential conceptual step of the process.



Once the industry supply and demand is established, projections of market share and prices can be estimated for an individual firm. The manner in which volume demand could be established from industry demand estimates could be established from a step by step process something like the following:

- Step 1: Compute the industry demand. Possible approaches to compute future demand include regression analysis, evaluation of historic volatility, extrapolation and judgment.
- Step2: Compute the industry supply from exiting supply as well as specific knowledge of expected new additions and expected retirements.
- Step 3: Compute the industry wide margin and attribute the industry margin to the company to develop company volumes assuming that market share is driven by the capacity of a company relative to total industry capacity as illustrated using the equation below.

$$\text{Reserve Capacity Percent} = \text{Industry Capacity} / \text{Industry Demand}$$

$$\text{Company Demand} = \text{Company Capacity} / \text{Reserve Capacity Percent}$$

- Step 4: Evaluate the price of the product as a function of the reserve capacity percent and the surplus capacity. In creating price assumptions an assumption can be made as to the price level relative to the amount of the surplus capacity. When the surplus capacity is high, the price can fall to marginal cost as discussed in Part 4. To implement changes in prices that result from the relationship between supply and demand, a LOOKUP function can be used. The LOOKUP function is more flexible and stable than either the VLOOKUP or the HLOOKUP functions. The LOOKUP function is illustrated below:

$$\text{Price} = \text{LOOKUP}(\text{Reserve Capacity}, \text{Reserve Capacity Range}, \text{Price Range})$$

Alternative Input Structures for Project Finance and Corporate Finance Models

The structure of inputs corresponds for corporate finance models and corporate models corresponds to the fundamental difference between corporate models and project finance models. Corporate finance models are built from history and virtually every input should be a time series variable that can vary from year to year. Further, the assumptions should be displayed adjacent to the history. In displaying the history aside the projected assumption, the assumptions can vary by time period or the assumption can remain constant. The excerpt below illustrates alternative assumptions for a corporate model using this idea. The first assumption for sales growth includes alternative time series variables that change from year to year. On the other hand the assumptions for working capital apply a single number that does not change from year to year. For sales growth, the different time series are driven by a code number that is shown in red (because it comes from another sheet that has a red tab colour). The fixed number that drives the projection of accounts receivable is also in shown in red, but is not a code number. The idea of using a code number to set up assumptions can be implemented with either the INDEX function or the CHOOSE function as explained in the next section.

Timeline		2009	2010	2011	2012	2013	2014	2015	2016
Base case		TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
Historic timeline switch		13							
Assumptions									
Operating assumptions									
Sales growth									
Historic sales		7.70%	-1.04%	7.75%	9.85%	FALSE	FALSE	FALSE	FALSE
Base sales					5.00%	5.00%	5.00%	5.00%	4.50%
Low sales					3.00%	3.00%	3.00%	2.00%	2.00%
High sales					8.00%	8.00%	7.50%	7.00%	6.00%
Sensitivity case				200	2.00%	2.00%	2.00%	2.00%	2.00%
Sales growth code number		1							
Actual/forecast sales growth		7.7%	-1.0%	7.8%	9.8%	5.0%	5.0%	5.0%	4.5%
COGS margin									
Historic margin		53.45%	52.33%	53.12%	53.10%	FALSE	FALSE	FALSE	FALSE
Base margin						53.00%	53.50%	54.00%	54.00%
Low margin						54.00%	56.00%	56.00%	55.00%
High margin						53.00%	52.50%	52.50%	52.50%
Sensitivity case				530		53.00%	53.00%	53.00%	53.00%
COGS margin code		1							
Actual/forecasted COGS margin		53.45%	52.33%	53.12%	53.10%	53.00%	53.50%	54.00%	54.00%
Working Capital Assumptions									
A/R to Sales Historic		6.87%	6.46%	6.69%	8.41%	FALSE	FALSE	FALSE	FALSE
A/R to Sales Projected		8.40%				8.40%	8.40%	8.40%	8.40%
A/R to Sales Actual and Projected		6.87%	6.46%	6.69%	8.41%	8.40%	8.40%	8.40%	8.40%
Inventories to CGS Historic		4.39%	4.50%	5.03%	5.63%	FALSE	FALSE	FALSE	FALSE
Inventories to CGS Projected		5.60%				5.60%	5.60%	5.60%	5.60%
Inventories to Sales Historic and Projected		4.39%	4.50%	5.03%	5.63%	5.60%	5.60%	5.60%	5.60%

In the case of project finance models, the format does not have the same structure driven by history. Some inputs may be One of the most important uses of financial models is to develop risk analysis discussed in the next chapter. To prepare the model of risk analysis, one should set-up inputs to the model in anticipation of the risk analysis through entering different possible scenarios in the data input section. For many inputs such as volume growth rates, prices, interest rates and other factors, different scenarios may have changing value over the forecast period. Mechanically, when inputs can take on different values over time and the task is to enter input data without inordinately cluttering up the model. An effective way to

Setting-up Inputs with Code Numbers and the INDEX Function

One of the most important uses of financial models is to develop risk analysis discussed in the next chapter. To prepare the model of risk analysis, one should set-up inputs to the model in anticipation of the risk analysis through entering different possible scenarios in the data input section. For many inputs such as volume growth rates, prices, interest rates and other factors, different scenarios may have changing value over the forecast period. Mechanically, when inputs can take on different values over time and the task is to enter input data without inordinately cluttering up the model. An effective way to enter input data with changing values over time and different possible scenarios is to use of forms together with the INDEX or CHOOSE. The general process of setting-up flexible input variables that can change over time at different date increments is summarized below:

Step 2: Enter data for a series of rows or columns associated with the input that can change over time. When entering there should be some time tag such as a year number or a date that can be used to associate the input with correct columns in the financial model.

Step 4: Once the variable is defined, use the LOOKUP function to insert the appropriate variable into the financial model. To use the LOOKUP function, use the relevant time period indicator in the financial model as the look up index. Then shade the time period in the input data and finally shade the items that will be transferred from the INDEX function.

Assumptions			33									
Timing												
Model start date	date	01-nov-10										
Development period	months	6										
Financial close	date	01-mai-11										
Construction period	months	24										
Commercial operation date (COD)	date	01-mai-13										
Operations												
Capacity per turbine	MW	3										
Number of turbines		20										
Capacity factor	Code no.	1										
	periods	date	P50 case									
	0	01-mai-13	25%								P50 case	
	1	01-nov-13	27%								P75 case	
	2	01-nov-14	29%								P90 case	
	3	01-mai-16	30%								P25 case	
	4	01-mai-18	32%								Sensitivity	
Inflation rate												
Code		1	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Base inflation rate		1	2.00%	2.00%	2.50%	2.50%	2.75%	2.75%	3.00%	3.00%	3.00%	
Low inflation rate		2	1.00%	1.00%	1.00%	1.50%	1.50%	1.50%	2.00%	2.00%	2.00%	
High inflation rate		3	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	
Base inflation rate			2.00%	2.00%	2.50%	2.50%	2.75%	2.75%	3.00%	3.00%	3.00%	
Date FIT awarded	date	01-nov-12										
Electricity Prices												
FIT	EUR/MWh	60.00										
Indexed	Switch	FALSE										

Part 1: Structuring and Programming Corporate, Project and Acquisition Financial Models

When filling out applications, when discussing your life and when evaluating your performance in various tasks ranging from sporting competitions to employment, one of the first questions that you are generally asked is your birth date. The same general notion applies to companies or projects, where dates, ages and life stages go a long way in defining the model. The starting point for a well structured financial model should be a carefully defined time line beginning that contains the starting point and ending point of an analysis, just as the most fundamental aspect of a person's life that is reported on his or her tombstone is the date of birth and the date of death.

Efficiently structuring the time periods assures that you can gauge the effect of issues such as the length of the holding periods of an acquisition, delays in the construction of a large project, lengthening of the life of a concession period in project finance, or evaluating the amount of time before which a stable growth rate is achieved for a corporation. From a mechanical perspective, carefully setting-up time periods allows calculations of items such as interest during construction, terminal value, depreciation and amortization, debt service reserve repayments, gain on sale of assets and other items. Much of the flexibility in a financial model comes from carefully setting up a time line.

Timing in Corporate Finance Models – Distinguishing the Historic Period, Explicit Period and Terminal Period so your Model will be Flexible and Adaptable to Financial Updates

A corporate model should contain a historic period, an explicit forecast period, a valuation date, a terminal period and sometimes a fade period. For these models, the structure of time periods should begin with definition of the historic period that is defined from the availability of financial statements and allows you to update the model with actual financial data. In corporate valuation and modelling there is a great deal of subjectivity in estimating future growth – you know that high growth cannot last indefinitely simply because of the law of large numbers. But claiming that you know exactly when growth will slow down and how much it will slow is not only arrogant, but fraudulent. When creating a model it is therefore useful to construct the model so as to be able to evaluate different periods before which the explicit forecast period ends.

The historic switch maybe the most essential concept in the efficient design of a corporate model. The most painful part of a corporate model is generally acquiring historic data (sometimes from copying PDF files) and finding the data for plant balances, maintenance capital expenditures, production levels and so forth. The last thing you want to do is to have to repeat this process over and over again each period new data becomes available. The time period switch can be established by using a simple logical variable just below the time period as follows:

$$\text{HISTORIC SWITCH} = \text{Year} \leq \text{Last Historic Year}$$

Placing a historic switch at the top of the page just below the years of the model allows you to do the following:

- You can change the last historic year and seamlessly add another year of data without having to change any of the formulas; without having to add columns and without having to change the valuation formulas in the model. When entering a formula for things like accounts receivables to revenues, you can make a formula that uses the historic switch as follows:

$$\text{Historic A/R to Revenues} = \text{IF}(\text{HISTORIC SWITCH}, \text{A/R Level/Revenues})$$

This formula produces a value of FALSE for periods after the historic period and will update the calculation when new data is entered as subsequent data becomes available. Often it is helpful to leave out the false condition in an IF statement and allow the model to present FALSE when something cannot be calculated. In this case the FALSE shows up in the projected years.

- You can model miscellaneous items such as other income as the last historic level or as a fixed level of zero by using another IF function as follows:

Historic/Projected Other Income = IF(HISTORIC SWITCH, Historic Level, Prior Level)
or
Historic/Projected Other Income = IF(HISTORIC SWITCH, Historic Level, AVERAGEIF(HISTORIC SWITCH, TRUE, Historic Amount))
or
Historic/Projected Other Income = IF(HISTORIC SWITCH, Historic Level, Fixed Level)

If the a fixed level is used, the fixed level should be shown in a cell at the left of the historic data after the titles.

- You can enter assumptions that have different levels for different years by using the INDEX function together with the HISTORIC SWITCH. An effective way to present assumptions is to show the historic level and then a series of different possible assumptions using a scenario code. In this case the formula is a bit long but very useful:

Historic/Projected Price = IF(HISTORIC SWITCH, Historic, INDEX(Scenario Column, Code))

- For other assumptions where the number can be constant such as accounts receivable to revenues, depreciation rates, earnings rates on associated investments, variable general and administrative costs and so forth, it is often simpler to enter a single number rather than a time series of changing assumptions over time. In this case the historic switch is used again, except that the second part of the if statement contains a fixed value. This fixed value should be shown in a separate cell to the left of the historic data between the titles.

Historic/Projected Rate = IF(HISTORIC SWITCH, Historic, Fixed Level)

- For some assets and liabilities that are held constant after the historic period, the HISTORIC SWITCH can be used with an IF statement to hold the values at the value of the last historic balance sheet using the following formula:

Historic Projected Balance = IF(HISTORIC SWITCH, Historic, Prior Level)

The excerpt below illustrates the various different ways the HISTORIC SWITCH can be used in developing assumptions and presenting the forecast next to the assumptions. The simple incorporation of a time switch allows the presentation of assumptions to be more transparent and the time switch also makes the model flexible with respect to the addition of new time periods when more data becomes available. The formula in column H illustrates how the historic switch in row 2 is used to develop different types of assumptions.

Year			2006	2007	2012	2013	2014
Historic Switch	2012		TRUE	TRUE	TRUE	FALSE	FALSE
Steel Price							
Steel Revenues		=I6	8,014	11,908	14,208	0	0
History		=IF(I2,I6/I7)	5.54	7.80	9.97	FALSE	FALSE
Base Price Case						10.00	10.00
Low Price Case						9.00	8.00
High Price Case						10.50	11.00
Price Sensitivity Case						10.00	10.00
Base Price Case	1	=IF(I2,I193,INDEX(I195:I198,\$F\$200))	5.54	7.80	9.97	10.00	10.00
Assumptions for Income Statements Not in EBITDA							
Other Income Statement Items							
Loss on Disposal/Impairment of Assets		=IF(I2,I19+I20,AVERAGEIF(I2:I2,TRUE,401:401))	41.00	33.00	469.00	290.29	290.29
Foreign Exchange Gains and Losses			48.00	-55.00	-41.00	1.43	1.43
Other Gains/Losses	0	=IF(I2,I28+I29+I30+I31,\$F\$403)	-49.00	-63.00	272.00	0.00	0.00
Income from Associated Investments							
Historic Income			40	88	1	0	0
Historic Balance Sheet Associated Investments			1,494	592	561	0	0
Average Balance of Associated Investments			1,494	1,043	612	281	0
Historic Return on Associated Investments		=IF(I2,I406/I408)	2.68%	8.44%	0.16%	FALSE	FALSE
Projected Return on Assot	5%					5.00%	5.00%
Historic/Projected Return on Associated Investments		=IF(I2,I410,I411)	2.68%	8.44%	0.16%	5.00%	5.00%

The HISTORIC SWITCH is also useful in after the inputs are developed and the working section to compute EBITDA or to compute depreciation and debt issues are developed. In computing items where growth rate assumptions are made, the growth rate assumption can be entered first and then the amount can be derived with the HISTORIC SWITCH as follows:

$$\text{Projected Amount} = \text{IF}(\text{HISTORIC SWITCH}, \text{Actual}, \text{Prior Year Amount} \times (1 + \text{Growth Rate}))$$

When working through assumptions it is useful to test whether all accounts have been included and whether the historic amounts computed correspond to the historic amounts reported in the financial statements. If the EBITDA is computed as revenues less operating expenses other than depreciation, the difference between the computed level and the reported level can be computed. Then, the difference can be summed over the historic period using the HISTORIC switch using the SUMIF function as follows:

$$\text{Sum of Difference} = \text{SUMIF}(\text{HISTORIC SWITCH}, \text{Computed difference}).$$

Once the sum of the difference is computed, a test can be developed by testing whether the sum is equal to zero:

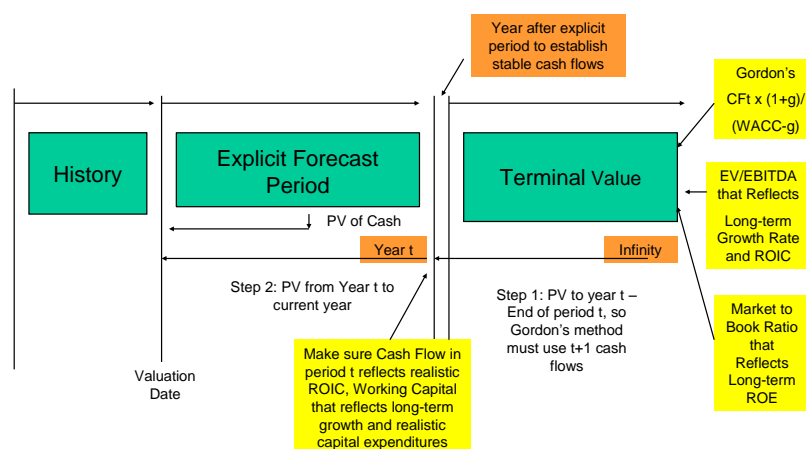
$$\text{Test of History: Sum of Difference} = 0$$

In creating various accounts in a corporate model such as the plant balance, the cash balance, the debt balance, the equity balance and others, the HISTORIC SWITCH can be used to move seamlessly from reported levels to projected levels. For historic years, the closing balance should come directly from the balance sheet while for projected years, the closing balance is the opening balance plus changes that are projected for the current period. Using the HISTORIC SWITCH in this manner is illustrated with the formula below:

$$\text{Closing Balance} = \text{IF}(\text{HISTORIC SWITCH}, \text{historic amount}; \text{opening balance} + \text{change})$$

Corporate models can also be structured to include a fade period in which cash flow growth declines from the rate achieved in the terminal cash flow period until a stable growth rate is obtained. In the fade period the growth rate in revenues moves from the relatively high short-term growth to a sustainable growth rate over the long-term, the operating margin may move for the current returns to returns that are reasonable to expect in the long-run and capital expenditures move to levels that are consistent with growth rates and the lifetime of the assets. The diagram below illustrates different time periods in a corporate model and the importance of the assumptions developed for the final forecast period.

Terminal Value in Corporate Model



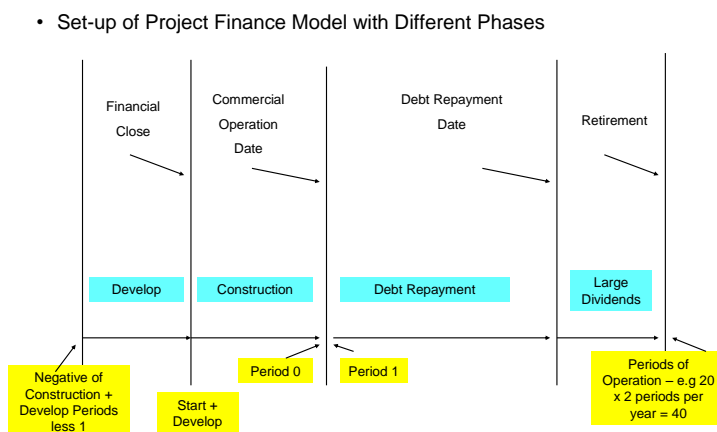
In modelling time periods for a corporate model, complications arise if the valuation date does not occur at the end of a calendar year (for example 1 March). The explicit period should be flexible so that the effects of different growth rates and returns can be evaluated. One of the tricky things in developing a corporate model is making the historic period flexible so that you can new historic periods without re-writing the model.

Timing in Project Finance Models - Different Phases in the Life of a Project from Development to Decommissioning

Structuring the dates is particularly important in project finance models where alternative accounting, financing and most importantly risk analysis occurs for different phases of the project. The stages that occur when making a new investment can include the time period when the project is being developed before construction – the development period; the period when construction occurs and investors are putting money into the projects; the period of operation of the project, and finally, the period in which the project terminates. Many mechanical calculations in a model are different for these different time periods. Further, the length of the periods in a model should be flexible and allow for the lengths of various phases of a project such as a delay in construction.

The number of periods can differ in project finance models depending on the phase of the project. In many project finance models, the construction period is presented on a monthly basis in order to accurately measure interest during construction since the calculation requires accumulation of debt for each month. On the other hand, when the plant begins operation, the model switches to semi-annual periods because of debt is repaid on a semi-annual basis. In order to construct time periods, one can create switches that define each phase of the project as well as the important millstone dates such as the financial close and the commercial operation date. The programming of different phases can become quite complex if the millstone dates do not start at the beginning of a month and if there are different time periods modelled in each phase of the project. The key behind making the modelling relatively simple is to make a period code which is one at the commercial operation date, negative during operation and development and measures the age of the project. After the model is created with detailed time periods, it is convenient to show numbers for an annual year, for a semi-annual period or a quarterly period if the model is constructed with detailed monthly periods.

The figure below illustrates how various stages of a project can be modelled with a period code. The mechanics of developing the various switches is discussed in the section below. The interesting theory associated with the different stages is how the value of a project changes as the risk of the project changes at different phases of the project.

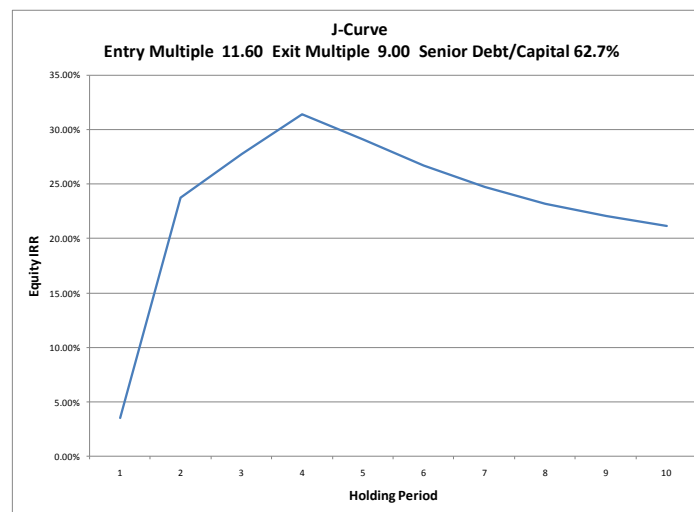


Timing in Acquisition Models – Separating the Transaction Period, the Holding Period and the Exit Period

In the case of acquisition models, setting-up time lines and time period indicators is just as important as corporate or project finance models so as to effectively measure risk and return. For acquisition models, different calculations are made for the acquisition period, the holding period and the terminal period. Through effectively setting-up time periods, a corporate model can be effectively converted into an acquisition model where dates of transactions can occur at different times, different historic periods can be added and alternative holding periods can be simulated. When initially constructing time periods in the model the following guidelines can be followed:

- The acquisition period should be a separate period in the model that only lasts one day so that the mechanics of the on-going calculations are not mixed up with the transaction assumptions.
- The period subsequent to the acquisition period can be a fraction of a year followed by annual periods until the final sale period.
- The exit period can be separate from the holding period in order to isolate on assumptions with respect to the sale of the company.

Developing periods in this manner allows the model to handle movements in the transaction date as well as alternative holding periods of the investment. As with a corporate model, one can evaluate what happens to the rate of return earned on a transaction when the holding period of the transaction changes. With the flexible time periods defined, a J-curve illustrating how the rate of return is affected by the length of time between the purchase and sale can be established as illustrated in the graph below.



General Ways to Structure a Time Line that Measures History, Explicit Periods and Terminal Periods in Corporate Models and Measures the Phases of the Life of a Project in a Project Finance Model

The remaining part of this section addresses mechanical issues with defining time lines, indicators and methods to facilitate different modelling and risk analysis techniques. A few issues that make the time line process more manageable for all project types include:

- Reserve a separate place in the model for the time line, whether on a separate page or a separate place above the beginning of the operating analysis.

- Begin the process by defining some kind of age variable (in your personal life, your age tells a lot about you; before you are born you are assumed to have a negative age).
- Explicitly show the start date and the end date of the model beginning with the first date of history, the date of the financial close or the date of the transaction depending on the model type.
- Explicitly define the periodicity of the model in terms of the number of months per period, the number of periods per year and the number of days per period (using either a 360 day basis with the DAYS360 function or a 365 day basis by subtracting the end date from the beginning date).
- Add switch variables for items such as the construction period in a project finance model and the historic period in a corporate model.

A financial model can be established on different periodic bases – annual, monthly, quarterly or semi-annually. It may seem a bit ridiculous to create a model with monthly information for ten years into the future when it is very difficult to predict what will happen one year from now. However, creating periods that are more finely defined than twelve month increments can be important in avoiding circularity and in reflecting the structure of alternative debt instruments. While it may seem a lot more complex to make a periodic model, with a bit of investment in creating switches and dates, the periodic modelling does not have to be painful.

Using Date Functions to Compute Start and End Dates for Each Period in Financial Models

To set-up a model that includes different project phases as in a typical project finance model, it is useful to begin with a period counter that measures how old the project is in each period (this is not necessary if the timing of the model does not change in different time period). Once the time period is defined, the dates of the model can be presented. These dates can be used to establish the phase of the project. To do this, you can use the following step by step process:

- First, the length of the pre-operation period should be defined in periods (e.g. months if the model is monthly during the construction period). If the beginning of construction and the beginning of operation is input as a date, then the construction period can be defined using a 360 day year where each month has 30 days as shown below. To compute the construction periods, use the DAYS360 function and enter the start date of construction and the commercial operation date (DAYS360(start date, completion date), then divide this number by the days per period (30 for a monthly model).

Start date of construction:	1-March-2010
End date of construction:	1-December-2015
Total Days of Construction DAYS360 (begin, end):	270
Construction Periods (Divide by 30):	69

- Second, once the period code is defined with a negative number for periods before you are born (i.e. before the operation period), create a TRUE/FALSE switch that delineates the pre-operation period from the operation period. This code that defines the time period before which the project is running (or is born) is created simply by the following statement:

Period Code > 1

- Third, use the time period code is to define the number of months per period. For example, the months per period may be one during the construction period and six afterwards. You can then use the period switch defined above to determine whether months per period in the model. (The one and the six in the equation below should be defined in the inputs).

Months per Period = IF(Construction Period, 1, 6)

- Fourth, enter the start date and the end date using the EDATE function as described in the paragraph below. The first beginning date is the established date and the ending date is the EDATE function with using the months per period. Start with the ending period (the first period is the start date of the model) and increment the date using the EDATE function and the months per period.

$$\text{Ending Period Date} = \text{EDATE}(\text{Beginning Period}, \text{Months per Period}) - 1$$

$$\text{Beginning Period Date} = \text{Ending Period Date} + 1$$

In general, it is not useful to work with days when incrementing dates. When increasing a date by one month, the new date cannot be incremented by simply adding days to the prior date (you cannot add 30.5 to the date for the previous month.) Instead of working with days, it is helpful to use the EDATE function or the DATE function. When using the EDATE function, the number of months is used to increment a date: EDATE (prior period, periods per year). If the DATE function is used, the YEAR, MONTH and DAY arguments of the function should refer to the previous date and the period per year should be added to the MONTH argument. Given the definition of periods for year from the switches above, the DATE function would be DATE(YEAR(prior date), MONTH(prior date) + periods per year, DAY(prior date)).

Including TRUE and FALSE Switches like Light Switches to Turn things on and off in Modelling Time Periods

Creation of switch variables to define phases of the models is an essential part of the process in making models flexible and transparent. When creating a switch variable that has a value of TRUE or FALSE think of a light switch that is on or off. In a project finance model, the construction phase, operating phase, debt repayment phase, and specific dates can be defined using switch variables that are on or off depending on dates defined in the model. In a corporate model switch variables should be developed for the historic period, the explicit forecast period and the terminal value period. Use of the logical variables that have a value of TRUE or FALSE already introduced above can be very helpful in the date section of a model because TRUE is equal to one and FALSE is equal to zero and because these switches eliminate the need for long IF statements. A switch can be created by simply using an equal sign (for example, = period or period <= 0). It can also be created using an AND, OR, or NOT function (for example, AND (period > 0, period <= retirement date) defines a switch for when the plant is operating. Establishing the TRUE and FALSE statements is also effective together with IF statements. One can simply use the TRUE or FALSE in IF statements and make the statements much easier to read.

Mechanically, the definition of various phases in a model can be developed by inputting various dates and then programming variables that contain switches. These switch variables which have a value of TRUE or FALSE can be used to set-up dates and program many variables that differ as a function of the phase of the investment. For example, various items may have different equations for the terminal period in a corporate model. To make programming less laborious you can make a variable that has a value of FALSE for each period except for the terminal period, which has a value of TRUE. An illustration of setting-up time period codes is shown below. In this example, each formula is very short and simple demonstrating the transparency objective of a model that should be easy to follow. When making a switch variable, the time line should not be fixed in the equation, but the criteria should be fixed (using the F4 key) as illustrated below for the terminal period and the explicit period in a corporate model. Assuming the time line is in row1, the switch is evaluated for column G, and the criteria for the terminal year is in cell D10, the formulas for the switches would have the following form:

Terminal Switch: Timeline Year (G1) = Terminal Date (\$D\$10)

Explicit Switch: AND(Timeline (G1) > Start Criteria (\$D\$11), Timeline (G1) <= Terminal Date(\$D\$10))

Start of period	<input type="checkbox"/> Show Comments		Fix	Base Case										
End of period					01-déc-12	01-janv-13	01-févr-13	01-mars-13	01-avr-13	01-mai-13	01-nov-13	01-mai-14	01-nov-14	
Year	From	To	Check		2012	2013	2013	2013	2013	2013	2014	2014	2015	
Development period	01-nov-10	01-mai-11	6	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	
Financial close date	01-mai-11	01-mai-11	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	
Construction period	01-mai-11	01-mai-13	24	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	
Commercial Operation Date	01-mai-13	01-mai-13	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	
Month before COD	01-avr-13	01-avr-13	1	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	
Operation period	01-mai-13	01-mai-33	40	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	
Debt Repayment Period	01-mai-13	01-mai-26	26	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	
Debt Retirement Period	01-mai-26	01-mai-26	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	
Re-financing Date	01-mai-17	01-mai-17	0		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	
Re-financing Repayment Period	01-nov-17	01-nov-30	26	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	

Examples of use of the switch variables later on in the model (which are either zero or one) include:

Construction Expenditures = Total Cost/Construction Period x Construction Period Switch
 Debt Balance = IF(historic period, actual amount, opening balance – repayments)
 Terminal Proceeds = Terminal EV/EBTIDA Ratio x EBITDA x Terminal Switch
 Interest during Construction = Interest Accrued x Construction Switch
 Stable Capital Expenditures = Capital Expenditures/Depreciation x Depreciation x Stable Switch

Once you are finished defining the detailed time periods, you can create an annual page that computes all or the variables on an annual or quarterly or semi-annual basis. This process involves using the SUMIF or the SUMIFS function along with clicking on entire rows of the spreadsheet page with detailed analysis (the page shown above). The way in which this process can be transparent and relatively simple is described in Chapter 3 under the sensitivity graph heading (as the annual numbers are often used to create graphs).

Annual Date = SUMIF(year row in periodic model, year in annual model, item in periodic model)

Computing the Age of a Project in Years in a Periodic Model that is Computed on a Monthly, Quarterly or a Semi-Annual Basis

When developing a model where time increments are not expressed on an annual basis (e.g. a monthly model or a quarterly model), it is sometimes useful to express the age of a project or an acquisition in years. Many inputs such as the credit spread, the operation and maintenance expense, production changes, the extraordinary maintenance and other variables depend on the age of a project rather than the calendar year and these variables are often expressed on an annual rather than a periodic basis. Computing the age of a project seems to be a simple issue, but it can be a little tricky. This is particularly true in cases where the number of periods is not constant over time; for example where a detailed monthly analysis is deemed necessary for the initial few years of a project life after which a quarterly model is used.

To compute the age of a project in years, you can use a simple two-step process is helpful. The first step is computing a variable that simply counts the number of periods (months, quarters, semi-annual periods) in the year. For example, in a monthly model, you would count from one to twelve and in a quarterly model you would count from one to four for each year in the model. The second step is to compute an age variable in years which increases once a new year has been reached. Increases in the age occur when the counter variable has a value of one. Difficulties in this process involve making sure that the counter begins with a value of one at the start of commercial operation and that counter variable re-starts when the periods of the model change. This step-by-step process is illustrated below:

Step 1: Compute a period counter variable. In a simple project finance model, this could be calculated using an IF statement where the counting re-starts after the maximum number of periods is reached:

IF(last period counter = maximum periods, reset to one, increment counter by one)

Step 2: Increment the age variable when the counter is equal to one. This is simply like having a birthday on one day (or month, or quarter) and increasing your age in years on your birthday.

IF(counter variable = 1, increase age, don't increase age)

Transferring Data from a Corporate Model to an Acquisition Model Using MATCH and INDEX Functions

One of the most useful techniques in excel that can be applied in many circumstances is using the MATCH and INDEX function together. One of the applications of this technique is to create timing of an acquisition model from a completed corporate model. Say a corporate model is completed on an annual basis with annual or quarterly data. Then you would like to transfer data into a new sheet that corresponds to an assumed transaction date (that may be in the middle of the period) you can use the following approach.

- Define a valuation date and the periods per year in the valuation analysis through creating a time line corresponding to the above methods that use the approach of a starting date and an un-even date using the procedures described above.
- Assuming the corporate model is computed on an annual basis and the acquisition model will be computed on a quarterly or a monthly basis, the YEAR function can be first used to define the yearly data to be transferred.
- Once the year is established the MATCH function that finds a row or column number can be used to associate dates in the acquisition model page with the corporate model. The best way to use the MATCH function is to not worry about shading partial columns and fixing ranges, but to use the entire row which finds the column number associated with the year from the corporate model:

Column Number = MATCH(year in acquisition model, Entire row of years in corporate model)

- Once the column number is established from the MATCH function, you can use the INDEX function that simply finds a variable given a row or column number or both. For example, assume the revenues are being transferred, then the INDEX function can be used as follows.

Revenue = INDEX(Annual Revenues, Column Number from Above)

Dates	1-May-11	1-Jan-12	1-Jan-13	1-Jan-14	1-Jan-15	1-Jan-16
Start Date	1-May-11	31-Dec-11	31-Dec-12	31-Dec-13	31-Dec-14	31-Dec-15
End Date	Base Case	2011	2012	2013	2014	2015
Year	2011	2012	2013	2014	2015	2016
Column from MATCH	16	17	18	19	20	21
Holding Period Switch	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Terminal Period Switch	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
Fraction of Year	67%	100%	100%	100%	100%	34%
Operating Section						
Annual						
Revenues using INDEX function	3,146.60	1,515.16	1,640.82	1,842.94	2,973.31	3,612.25
Expenses using INDEX function	3,068.40	1,520.94	1,542.01	1,701.20	2,781.63	3,273.64
Capital Expenditures	366.80	72.72	73.45	74.55	688.82	104.77
Synergies	80.00	80.00	80.00	80.00	80.00	80.00
EBITDA	158.20	74.23	178.82	221.74	271.68	418.61
Periodic						
Revenues	2,097.73	1,515.16	1,640.82	1,842.94	2,973.31	1,214.12
Expenses	2,045.60	1,520.94	1,542.01	1,701.20	2,781.63	1,100.31
Capital Expenditures	244.53	72.72	73.45	74.55	688.82	35.22
Synergies	53.33	80.00	80.00	80.00	80.00	26.89
Terminal Proceeds						
Exit EV/EBITDA	12.00	12.00	12.00	12.00	12.00	12.00
Exit Proceeds	-	-	-	-	-	5,023.33

Projecting Inflation, Revenues, Expenses and Capital Expenditures in Working Analysis

In constructing the working section of a model that projects essential free cash flow items – revenues, operating expenditures and capital expenditures, making clear presentations using short formulas that are easy to follow should guide the modelling process. Many of the items are modelled using the time period switches discussed above. For example, in a project finance model the capacity of a project begins during the operating period which is defined with a switch. In a corporate model, the gross margin is computed using actual data with the historic switch and then switches to the assumptions when the historic period is FALSE. When computing formulas for inflation projections associated with these items, various problems can arise when time period lengths change and when intervals are used for inputting the inflation rate and when the starting point for inflation indices are not clearly laid out in the input section. In general inflation should be included in the analysis as it is more difficult to convert depreciation and taxes into real terms than add inflation and use the nominal cost of capital.

Interest rates and inflation rates are generally input into a model as annual rates. But when modelling inflation rates using non-annual periods, it is not accurate to simply compute the fraction of the year and multiply this by the annual percentage in a periodic model. This can result in overstatement of interest or inflation because amounts will be compounded in a model. For example, assume the annual inflation rate is very high, say 120%. If the real expenditure for the year before the year's inflation is 100, then it would be 220 including the inflation. If 10% is assumed per month, then by the end of a year with, the inflation index compounds to 3.38 rather than 2.20. To resolve this problem of over-compounding, a periodic rate can be derived using the following process.

$$\text{End of period expenditure} = \text{Beginning of period} \times (1 + \text{periodic rate})^{\text{periods}}$$

and,

$$\text{End of period expenditure} = \text{Beginning of Period} \times (1 + \text{annual rate})$$

or,

$$(1 + \text{periodic rate})^{\text{periods}} = (1 + \text{annual rate})$$

$$(1 + \text{periodic rate}) = (1 + \text{annual rate})^{(1/\text{periods})}$$

$$\text{periodic rate} = (1 + \text{annual rate})^{(1/\text{periods})} - 1$$

To practically apply the above formula, you can use the fraction of a full year that the model period represents as illustrated in the formula below:

$$\text{Periodic Rate} = (1 + \text{annual rate})^{(\text{months per period}/12)} - 1$$

Finally, when establishing the inflation rate one should be careful about the start date. When inflation assumptions are made, the fundamental data for prices, operating expenses and capital expenditures per unit are input in real terms at some given date. To start the inflation index at the appropriate date, you can create a switch and only turn on the inflation rate after the inflation start (this will keep the inflation index at one until the beginning of the inflation period.) The diagram below illustrates components of a working analysis with varying inflation.

Project size	MW	10	-	-	-	-	-	-	-	-	-
Days per period	#		30	30	27	30	29	30	29	30	30
Hours per period	h		720	720	648	720	696	720	696	720	720
Annual degradation	% annual	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%
Periodic degradation			0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Degradation index		1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Base Capacity Factor	%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
Low CF Years in Risk Analysis	Year	5.00	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Capacity Factor in Low Years	%	12.00%	12.00%	12.00%	12.00%	12.00%	12.00%	12.00%	12.00%	12.00%	12.00%
Capacity Factor from Above			15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%
Applied Capacity Factor	%	TRUE	16.70%	16.70%	16.70%	16.70%	16.70%	16.70%	16.70%	16.70%	16.70%
Generation	MWh		-	-	-	-	-	-	-	-	-
General Inflation	annual %		1.78%	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%
Periodic inflation	Periodic %		0.15%	0.14%	0.14%	0.14%	0.14%	0.14%	0.14%	0.14%	0.14%
Inflation index		1	1.001	1.003	1.004	1.006	1.007	1.009	1.010	1.011	1.013
General Inflation			1.78%	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%
Periodic inflation			0.15%	0.14%	0.14%	0.14%	0.14%	0.14%	0.14%	0.14%	0.14%
Inflation index		1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Total Capital Cost	EUR 000 / MW	1,200									
Weibull Function for Spreading Cost	%		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Normalized S-Curve with Weibull Function	%		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
S-Curve Test	Switch	TRUE									
CAPEX spread with Inflation	EUR 000		-	-	-	-	-	-	-	-	-

Valuation Analysis after Computing EBITDA from Revenues and Expenses and Evaluating Pre-tax Project IRR in Project Finance Models or Pre-tax ROIC in Corporate Models

Once you have computed revenues, expenses and capital expenditures you can stop and compute a few financial ratios. In a project finance model you can calculate the pre-tax project IRR from EBITDA minus capital expenditures. In corporate models you can compute the level of EBITDA to net assets that generate EBITDA. In project finance models, if the pre-tax IRR that can be computed on a real and nominal basis is lower than the interest rate, then you do not have to go any further with all of the tax and financing aspects of the model as the project will probably not be feasible. On the other hand, if the pre-tax project IRR yields a very high number, you should step back and ask yourself what makes you so special and why this high IRR will not prompt companies from all over the world to try and copy your project which will put a whole lot of pressure on prices, margins and fixed price contracts.

In a corporate model, computing the level of EBITDA to net assets accomplishes a similar task. The net assets can be computed from the accumulated capital expenditures. Once the ratio is computed which is analogous to the pre-tax IRR, the projected levels can be compared to the historic ratio. This notion of comparing history with projection is further discussed in Part 3 and allows you to judge whether you have made reasonable assumptions. If the rate of return on assets skyrockets compared to the history you need to ask what has changed about the company that allows it to earn such high returns. What you probably need to do in this case is go back and revisit your assumptions.

Chapter 8: Moving from EBITDA and Capital Expenditures to Free Cash Flow through Creating Working Capital Analysis, Fixed Asset Schedules and Depreciation so that Project IRR and ROIC can be Calculated

Computing Free Cash Flow before Developing Financing Section of a Model

You may be repulsed by the idea of Miller and Modigliani or may be a true believer in free cash flow and the irrelevance of the financial structure in assessing value. No matter what your opinion of the theory, the general approach of separating a financial model between operations and financing improves the

structure of any financial model including project finance models, corporate models and acquisition models. Through first calculating free cash flow and only then adding the debt and equity split in the model, the structure is more logical and rigorous. Once free cash flow is computed from EBITDA less capital expenditures, working capital changes, operating taxes and changes in deferred taxes, a host of valuations and financial statistics can be computed. In a project finance model the project IRR (but not the equity IRR) can be computed and the value of the project assets at different sale dates can be evaluated. In a corporate finance model the return on invested capital (but not the return on equity) can be derived and the discounted cash flow value can be established. Given the usefulness of separating operating cash flow from equity cash flow, the next section addresses working capital, depreciation and deferred tax items that are necessary to complete the free cash flow calculation.

Working Capital Analysis

Once revenues, expenses and capital expenditures are established, the remaining items to compute free cash flow are the working capital changes and taxes. Working capital is often computed in a simple manner directly from revenues and operating expenses in a simple way through inputting the ratio of accounts receivables to revenues, inventories to cost of goods sold and so forth. For this purposes of constructing a model, working capital includes trade working capital and does not include cash, short-term securities, short-term debt or current maturities of long-term debt. For example, if the days outstanding are 30, then one month of revenues is not collected, or about 8.33% of total revenues. The working capital section must be developed after revenues and expenses have been computed. After computing the total current assets and current liabilities, working capital is computed as the difference between the two amounts. Finally, the change in working capital is the current period working capital less the prior period working capital.

One complexity in computing working capital can involve computing inventories and accounts receivable during periods of declining demand such as occurred after the financial crisis of 2008. In a detailed model, the production can be computed separately from demand. Additions to inventories can be modelled as a function of production while deductions from inventories can be modelled as a function of demand. If there is a sudden reduction in demand without a similar reduction in production, the inventory balance will increase.

Basic Asset Schedule and Introduction to Problems in Computing Depreciation Expense in Corporate Models Involving Retirements

In corporate finance models, project finance models and acquisition models a well structured analysis will calculate free cash flow before incorporating financing of assets. There should be a clear distinction between financing and operating analysis consistent with finance theory. The basic free cash flow definition -- EBITDA less working capital changes, less capital expenditures and less operating taxes can guide analysis before financing. Previous discussion covered the modelling of revenues, expenses, capital expenditures and working capital that are all components of the free cash flow calculation. The remaining item necessary to compute free cash flow is the level of operating tax defined as the tax rate multiplied by the EBIT. This is a hypothetical amount of tax that would be paid if the company were financed entirely with equity and had no interest expense, interest income or income from other activities not related to operations. In order to calculate EBIT and derive operating taxes a projection of depreciation expense is necessary. Therefore, calculating the plant assets along with depreciation is the next logical part of the structure of financial models.

Accurately representing depreciation expense in a model is important because tax depreciation effects actual tax payments; because depreciation expense affects taxes used in computing free cash flow; because depreciation expense is used in terminal value calculations where the ratio of capital expenditure to depreciation expense may be used in computing stable ratios; because depreciation expense effects reported earnings; and because the net plant depreciation rate can be used in deriving stable EV/EBITDA ratios. Unfortunately, the calculation of depreciation in a corporate model can be one of the most tricky aspects of the whole process. Much of the discussion in Part 3 of the text associated with stable ratios in

a discounted cash flow analysis and computing the implied EV/EBITDA ratio builds from ideas presented in this chapter.

A few difficult programming issues can arise in modelling depreciation expense in the different types of models. The biggest problem is in corporate models related to evaluating the effects of asset retirements that come about because of historic capital expenditures that were made before the start of the forecast period. Further, the retirements for projected capital expenditures must look backward to the time at which the capital expenditures were made. If the depreciation rate is not straight line, the age of each tranche of capital expenditure must be remembered so that one can look-up the appropriate depreciation rate. For a project finance model, the retirement problem for existing assets does not exist because there is no history, but other programming problems arise because the depreciation expense may be a function of the calendar year rather than the annual age of the project. Depending on the tax treatment of a transaction, distinguishing tax depreciation and book depreciation can be difficult and modelling accelerated depreciation can create challenges in acquisition models. Many of these difficult modelling issues can be resolved with a few user defined functions. These functions include:

- Vintage depreciation
- Implied historic capital expenditure pattern from growth rates
- Implied historic growth rates from accumulated depreciation to gross plant

Portfolios of Assets with a Vintage Process

Corporate models may include tax depreciation as well as book depreciation as tax depreciation rather than book depreciation affects true taxes paid and cash flow. If EBIT is computed using book depreciation in the free calculation, then there should be a separate adjustment for changes in deferred taxes derived from calculation of tax depreciation in the calculation. The more correct calculation is:

$$FCFF = EBITDA - WC \text{ Change} - Capital \text{ Expenditure} - EBIT \times \text{tax rate} + \text{Change in Deferred Tax}$$

Computation of tax depreciation can be complex when the depreciation rate is not constant for each year if accelerated depreciation rates are part of the tax code. To model tax depreciation with accelerated rates and continuing capital expenditures, a matrix with a diagonal pattern is often shown in models as the depreciation expense for an asset depends on its age and information on both the age and the capital expenditure must be retained for the calculation. These fancy looking matrices are sometimes shown for straight line depreciation which is not necessary as the depreciation rate does not depend on the age of the asset (perhaps modellers want to show how sophisticated they can be). The table below illustrates calculation of accelerated depreciation for assets with an assumed four year life.

Model Year		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Capital Expenditure		200.00	218.00	237.62	259.01	282.32	307.72	335.42	365.61	398.51	434.38	473.47
		1	2	3	4	5	6	7				
	Dep Rate	0.2	0.3	0.2	0.1	0.1	0	0				
Born Yr	Cap Exp	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
2014	200.00	40.00	60.00	40.00	20.00	20.00	-	-	-	-	-	-
2015	218.00	-	43.60	65.40	43.60	21.80	21.80	-	-	-	-	-
2016	237.62	-	-	47.52	71.29	47.52	23.76	23.76	-	-	-	-
2017	259.01	-	-	-	51.80	77.70	51.80	25.90	25.90	-	-	-
2018	282.32	-	-	-	-	56.46	84.69	56.46	28.23	28.23	-	-
2019	307.72	-	-	-	-	-	61.54	92.32	61.54	30.77	30.77	-
2020	335.42	-	-	-	-	-	-	67.08	100.63	67.08	33.54	33.54
2021	365.61	-	-	-	-	-	-	-	73.12	109.68	73.12	36.56
2022	398.51	-	-	-	-	-	-	-	-	79.70	119.55	79.70
2023	434.38	-	-	-	-	-	-	-	-	-	86.88	130.31
2024	473.47	-	-	-	-	-	-	-	-	-	-	94.69
Total		40.00	103.60	152.92	186.69	223.49	243.60	265.53	289.42	315.47	343.87	374.81

To model one of these matrices, the biggest trick is to compute the age of separate assets that are projected to be completed at different times. In the above example, the age of the asset class that goes into service in 2015 is one year old in 2015, while the age of the asset class that went into service in 2014 is two. A square can be created that shows the date the asset is born and the date of the model that allows the age at each vintage to be computed. Once the age of each vintage of plant for each asset class is established, the lookup function can be used with the age as the index to find the appropriate depreciation rate. To make the calculations, the following steps can be used:

- Step 1: Enter the depreciation rate as a function of the age of the plant.
- Step 2: Use the TRANSPOSE function (not the copy and paste special) to set up a matrix that has the year the asset was created on the column and the year of the model on the row. To use the TRANSPOSE function, first shade the target area, then type the function name and finally press SHIFT, CNTRL, ENTER instead of simply pressing the enter key. The result called an array variable will include brackets around the result.
- Step 3: Compute the age of the plant through subtracting the model year from the year the asset was born. Allow the age to be negative in years before the asset was created (use relative references by pressing the F4 key multiple times)
- Step 4: Use the LOOKUP function to relate the depreciation rate to the vintage of the plant by applying the age as the lookup index and then shading the age in the depreciation table and then shading the rate.
- Step 5: Multiply the depreciation rate by the cost of the asset being depreciated from the cost of the asset that was created from the TRANSPOSE function and use the IFERROR function (in excel 2007 and later) to avoid problems created by N/A.
- Step 6: Repeat the process for assets with different vintages and with book and tax depreciation.

Instead of this rather long process, you can create your own function with a few lines that accepts capital expenditures and depreciation rates and gives the depreciation expense. You do not show the fancy diagonal matrix, but the modelling is much faster. The function is like the TRANSPOSE function in that the output – period by period depreciation expense -- does not go into one cell, but rather into an array of cells. To create a function that produces a row or column of depreciation expense from an array of capital expenditures and an array of depreciation rates, you need to know a couple of tricks in computing an array function. Three elements in generating an array function include:

1. Define the function as a VARIANT
2. Compute the length of the array by using the .COUNT extension

3. Create an array variable for depreciation expense using the REDIM statement to define the size of the depreciation array
4. Assign an array variable to the name of the function (rather than a single value)

Once you know these things you can create many functions that can make your models far more efficient. The code that produces total depreciation from computing vintages is shown below. After you create it one time you will not have to program the matrix again. Hopefully, this example illustrates the benefits of using functions in excel. You can copy this function into your models or you can create an add in file that contains all of your functions.

```
Function depreciation(capital_expenditure, depreciation_rate) As Variant    ' When the output is an array define as Variant
asset_life = depreciation_rate.Count    ' Find Life from the depreciation rate array
cap_exp_periods = capital_expenditure.Count    ' See how many capital expenditure periods are modelled

ReDim Depreciation_Expense(cap_exp_periods) As Single    ' Make a new array variable that is the output

For model_year = 1 To cap_exp_periods    ' loop around each period
    For vintage = 1 To cap_exp_periods    ' make a second loop to evaluate asset by asset
        age = model_year - vintage + 1    ' calculate the age of each expenditure (the diagonal)

        If (age > 0 And age < asset_life) Then    ' Only when asset is alive
            Depreciation_Expense(model_year) = _
                capital_expenditure(vintage) * depreciation_rate(age) + Depreciation_Expense(model_year)
        End If
    Next vintage    ' Note that the vintage is usef for the capital expenditure
Next model_year

depreciation = Depreciation_Expense

End Function
```

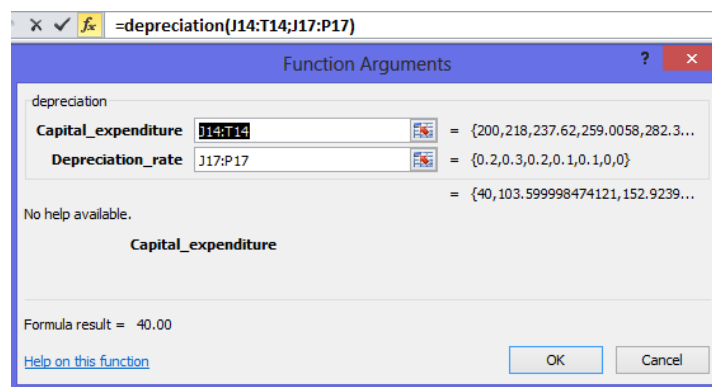
The function that produces an array in the above case only allows you to create the function in a single row. If you would like to output a row as well as a column, the output variable can be defined as a two dimensioned array. An additional loop could then be created that defines the second part of the array as using the same value as the first as illustrated below:

```
ReDim Depreciation_Expense(cap_exp_periods,cap_exp_periods) As Single

For i = 1 To cap_exp_periods
    For j = 1 To cap_exp_periods
        Depreciation_Expense(i,j) = dep(i)
    Next j
Next i

depreciation = Depreciation_Expense
```

To implement a user defined function it is helpful to describe the inputs to the function with descriptive variable names and then use the f_x thing next to the data entry box. Then you can see the variables required by your function as illustrated below.



This function can also be used in project finance models where the timing of future capital expenditures is variable. In this case, you simply select the entire series of future capital expenditures all of which can be zero except one.

The Painful Problem of Coming Up with a Method the Accounts for Asset Retirements in Corporate Models in an Unbiased Manner

Addressing the problem of asset retirements in corporate models is difficult because information on the plant retirements associated with previously built plant is difficult to obtain as it depends on previous capital expenditures that occurred a long time ago, write-offs, asset sales and revaluations for many historic years. As this information is virtually impossible to obtain, modellers have developed various different methods to solve the problem. Modellers generally firmly believe in their approach and have elegant arguments to support their position. But they cannot really prove their method is accurate. In this section different methods for simulating depreciation and incorporating retirements are addressed.

To measure the benefits and problems of alternative depreciation modelling methods, it is useful to develop a long-term hypothetical model that computes the theoretically correct level of depreciation expense that you can use as the basis of comparison. When developing a theoretical model of the true depreciation expense you should keep in mind the most fundamental aspect of corporate models. That is related to the fact that corporations have a history, an indefinite life and that the model cannot cover all of the periods of the model. A theoretical model that covers the start-up of the firm, a historic period, a modelled period and a long-term stable period can be used to prove which modelling method is accurate in modelling capital assets, retirements, depreciation expense and net plant depreciation rates. The theoretical model that includes different growth rates for each period can produce the true depreciation, the true retirements and the true cash flow for alternative start dates. Once this theoretical base is established alternative methods such as the net plant depreciation method can be tested against the true value. One can evaluate what kind of growth rate assumptions produce big errors and if alternative approaches can be developed.

In developing a theoretical base, one can input different growth rates for different periods (the historic period, the modelled period and the long-term period). The growth rates are used to determine the balance of plant that is required to support the EBITDA (if there is a higher growth rate in EBITDA, a higher growth rate in plant is necessary). The plant balance can then be used to derive the implied level of capital expenditures. This is a bit tricky because the change in plant includes the retirements of plant. The capital expenditures are given by the formula:

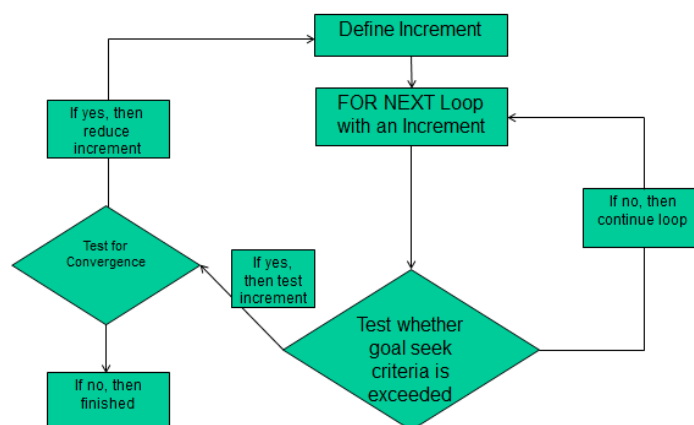
$$\text{Change in Plant} = \text{Plant}_1 - \text{Plant}_0 = \text{Capital Expenditures} - \text{Retirements}$$

$$\text{Capital Expenditures} = \text{Plant}_1 - \text{Plant}_0 + \text{Retirements}$$

Retirements can be determined by the amount of money spent on capital expenditures in earlier periods. For example if the plant life is five years, then retirements are the amount of capital expenditures that occurred five years ago. When simulating retirements as the lag in capital expenditures, one problem is that retirements cannot be computed until a full life cycle of plant has completed. The first part of a formula for retirements should therefore be an IF statement involving whether the year is greater than the life of the plant – before this year there are no retirements related to the capital expenditures. When the period is greater than the lifetime, the retirements can be computed. After the first life cycle is complete, retirements should look backward from the current year by the length of the life of the plant. Looking backward can be accomplished using the OFFSET function that begins with a cell and moves up or down and backward or forward:

Retirements = IF(Year >= Asset Life, OFFSET(capital expenditure cell,0,-Asset Life))

The remaining problem with retirements is that the retirements associated with the initial gross plant must be simulated. To do this one can assume that the historic gross plant was accumulated through making capital expenditures at a constant growth rate. This can be accomplished by deriving the capital expenditures that were made a lifetime ago to sum to the rate. You could compute this amount with a goal seek formula. But this is tedious to put in a model. Instead, you can create a flexible function that does the same thing as the goal seek. The trick to making a function that does the same thing as a goal seek is to make a FOR NEXT loop that has a small increment. You go around the loop until the goal seek criteria is met. Once you have exceeded the goal seek criteria, you go back and reduce the increment. You do this until the increment is very small and the value is found. The process of making a flexible goal seek that is flexible and changes when you change inputs is illustrated in the diagram below:



The function to create a flexible goal seek formula is shown below. Note that all of the formulas for computing the goal seek must be contained in the function. You cannot create such a function with a big model to do something like find the price to meet a target IRR.

```
'
' This function finds the capital expenditures that were made at the beginning of the life
' It is the automation of a goal seek function
'

Function find_base(growth, life)                                ' Backs into the percentage starting point

min_base = 0                                                    ' Set initial low value for testing
max_base = 1                                                    ' set the cap for testing

new_increment:                                                  ' after exceeded test, come back to this point

    increment = (max_base - min_base) / 10                      ' Re-compute Increment

    For base = min_base To max_base Step increment              ' loop around smaller and smaller increment for base

        plant = base                                            ' Try different values for base
        total_plant = plant                                     ' This is the integral of the plant. You are aiming for 1

        For i = 1 To life - 1                                    ' Go around life to compute the total -- you are aiming for 1.0
            plant = plant * (1 + growth)                        ' Increase the plant by the growth rate
            total_plant = total_plant + plant                    ' Add the plant together (integrate)
        Next i

        If total_plant > 1 Then                                    ' When base is too high go back and try again; if not, continue
            min_base = base - increment                          ' Find a smaller starting point
            max_base = base + increment
            GoTo new_increment
        End If

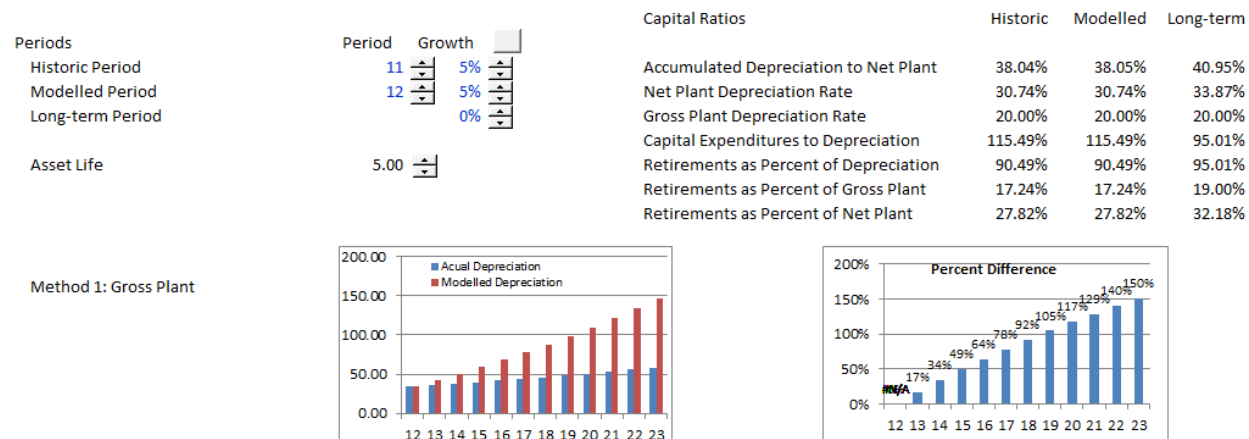
        If Abs(total_plant - 1) < 0.0000000001 Then              ' Test for convergence
            find_base = base
            Exit Function
        End If

    Next base                                                    ' Loop over base

End Function
```

Alternative Methods for Deriving Retirements Associated with Existing Assets in a Corporate Model

For a single asset with no terminal value, straight line depreciation is simply the gross amount spent on an asset divided by the plant life. Given this fact, one approach to computing depreciation expense is to keep track of the balance of the gross plant (i.e. without deductions for accumulated depreciation) from a table beginning with existing plant and adding capital expenditures. As explained earlier, the gross plant can be set to actual gross plant during the historic period and computed as the opening balance plus the capital expenditures in the projection period using a historic switch. Gross plant balance can then be multiplied by the depreciation rate to establish projected depreciation. The problem with this method is that it does not account for any retirements associated with existing plant. By ignoring retirements, the method overstates depreciation expense and it can lead to underestimation of taxes. Cash flow is overstated because gross plant never declines as assets are retired. The problem is worse when the asset life is short and when the growth rate is slow. When the asset life is short, there should be a lot of retirements on exiting plant that are ignored and when the growth rate is slow, the retirements approach 100% of depreciation. The excerpt below demonstrates that when the growth rate is 5% and the asset life is 5 years, the overstatement of depreciation approaches 100% after a few years. The comparison between modelled depreciation and true depreciation is derived from the theoretical computation of depreciation discussed in the prior section.



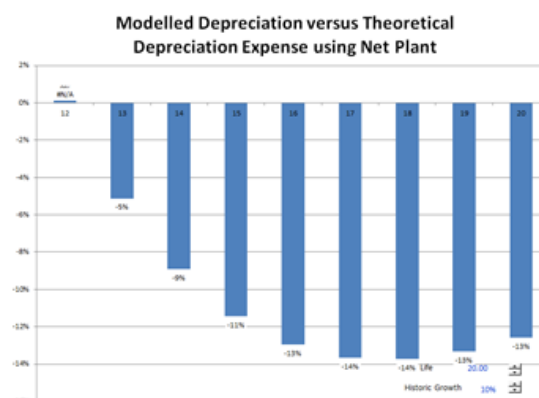
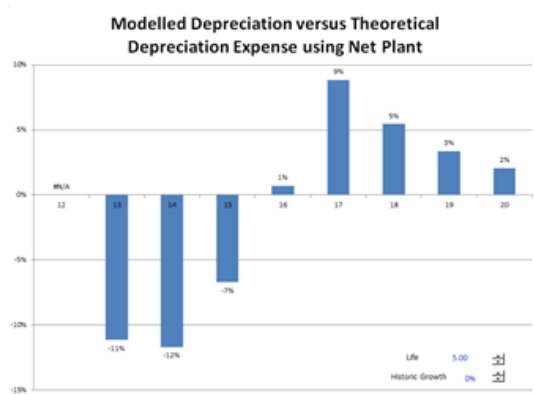
A second approach sometimes used is to separate the depreciation on existing assets from the depreciation on new assets. A separate schedule for the depreciation on new assets is computed using the vintage method described above. The depreciation on existing assets can either simply continue the existing level of depreciation or decline to account for retirements. The existing depreciation should also account for the capital expenditures made in the final historic year. If the existing level of depreciation does not reflect retirements and the lifetime of new assets is fairly long, the method is not very different than the above method. In this case there are no retirements of new assets or existing assets in the analysis and the depreciation is overstated. If retirements on existing assets are accounted for, some kind of retirement statistic must be entered and then the accumulated retirements should be calculated. Once the accumulated retirements are tabulated, the adjustment to existing depreciation can be computed as the accumulated amount multiplied by a depreciation rate. Further, a MIN test should be included so that the depreciation on the retirements do not exceed the existing depreciation expense. This approach to depreciation expense is illustrated in the excerpt below. When these adjustments are made, the depreciation expense is more accurate. The problem with this method is that it is a bit tedious to implement and one needs information on historic growth and the retirements as a percent of depreciation expense.

Period	Test	Growth	0	10	11	12	13	14	15	16	17	18
Historic Period	11	5%		TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Modelled Period	9	5%		FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Long-term Period	280	0%		FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Test	TRUE			TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Simulated Depreciation Method TWO - Existing Depreciation Flat and New Depreciation												
Existing Depreciation			0.00	34.21	34.21	34.21	34.21	34.21	34.21	34.21	34.21	34.21
Retirements to Depreciation			0.00	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Retirements			0.00	30.95	30.95	30.95	30.95	30.95	30.95	30.95	30.95	30.95
Accumulated Retirements			FALSE	FALSE	30.95	61.91	92.86	123.81	154.76	185.72	216.67	
Depreciation on Retirements			0.00	0.00	0.00	6.19	12.38	18.57	24.76	30.95	34.21	
New Plant Balance												
Opening Balance			0.00	0.00	0.00	39.50	80.98	124.54	170.27	218.29	229.20	
Add: Capital Expenditures			FALSE	FALSE	39.50	41.48	43.55	45.73	48.02	50.42	52.94	
Less: Retirements			FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	39.50	41.48	
Closing Balance			0.00	0.00	39.50	80.98	124.54	170.27	218.29	229.20	240.66	
Depreciation Rate			0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Depreciation Expense			0.00	0.00	0.00	7.90	16.20	24.91	34.05	43.66	45.84	
Total Modelled Depreciation			0.00	34.21	34.21	35.92	38.02	40.54	43.50	46.91	45.84	

To approximate retirements, some modellers project depreciation on existing assets using the net plant balance multiplied by the net plant depreciation rate and separately compute the depreciation on new assets. As the balance of net plant declines each period, the depreciation expense also declines implying that retirement of assets for existing assets is implicitly reflected in the forecast. If this net plant method is

used, one must make sure that the net plant balance does not become negative. Although this approach of splitting-up depreciation does indirectly account for retirements, it is not an accurate reflection of retirements unless the rate of retirement for existing assets (relative to net plant) is the same as the net plant depreciation rate. The approach assumes that if the net plant depreciation rate is 15%, then the implicit retirement rate percentage of existing assets is also 15%. Unless the growth rate for the historic period is zero, there is no basis for making this assumption. Another problem with this approach is that, the depreciation rate on net plant does not remain constant over the lifetime of existing assets. If the retirements are less than depreciation, then the depreciation rate on net plant will increase as the net plant balance declines. Over the lifetime of a single asset, the ratio of depreciation expense to net plant – the gross plant less the accumulated depreciation expense – declines as depreciation remains constant but net plant reduces. For a company or project with many assets, multiplying net plant by a constant depreciation rate can also result in biased forecasts because the depreciation rate on net plant is affected by the growth rate of the company and when growth rate changes, the depreciation rate on net plant also changes.

The pattern of errors from applying the net plant method is illustrated below for cases with different growth and different plant lives. The left panel demonstrates the method understates depreciation in early years, but overstates depreciation in later years with a short life and a low growth rate. The right panel shows the depreciation is consistently understated using the second method. Where depreciation is understated, the cash flow is understated and the income is overstated. If you are using the formula $NOPLAT \times (1-g/ROIC)/(WACC-g)$ then the understatement in depreciation results in an understatement of terminal value. Finally, note that the error in computing depreciation is less using the net plant method than the error from ignoring retirements.



The third method introduced is to directly model the retirements using the historic growth rate and to separately model the new assets using a vintage approach. Application of this method requires two user defined functions and computing retirements associated with the existing assets. With the two functions and information regularly reported on the financial statements you quickly make the more accurate calculation. To make a more accurate calculation of depreciation on existing assets from the theoretical retirements you can follow the following step by step process:

Step 1: Find the ratio of the accumulated depreciation to net plant from the historic financials

Step 2: Compute the **implied historic growth** from the accumulated depreciation to net plant by making a user defined function. This function is similar to the function discussed above to find the base level of retirements. If is a function that does the same thing as a goal seek on a dynamic basis. You start with a loop from -100% growth to 100% growth and step around by 1%. Then you compute the ratio of accumulated depreciation to plant. Once the target ratio has been found, you make a smaller increment than 1% and make another loop. You repeat the process until the computed ratio of accumulated depreciation to plant just equals your target level.

Step 3: Compute the **base retirements** as a percent of gross plant by using the base retirement function defined above. Recall that this function accepts the growth rate and the plant life, both of which have now been determined.

Step 4: Compute retirements of the existing plant over the projected period. This can be accomplished by making a switch for the first modelled period. In this period the retirements are the opening plant balance multiplied by the base retirements established above. For subsequent periods, the retirements are the prior value of retirements multiplied by the growth rate computed in step 2. The formula for retirements is:

$$\text{Existing Retirements} = \text{IF}(\text{First Modelled Period}, \text{Opening Gross Plant} \times \text{Base}, \text{Prior Value} \times (1 + \text{Growth}))$$

Step 5: Compute the balance of plant, the depreciation on existing plant and the depreciation on new plant.

An example of this process for computing the depreciation is demonstrated below.

Period	Test	Growth	0	15	16	17	18	19	20	21	22	23	24
Historic Period	16	7%	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Modelled Period	17	10%	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Long-term Period	267	10%	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Test	TRUE		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Parameters													
Life	6.00												
Accumulated Depreciation From History	38.39%												
Implied Historic Growth	6.99%												
Base Retirements	13.98%												
Existing Deprecation													
Opening Balance			257.85	275.90	295.22	253.94	209.77	162.52	111.96	57.87	0.00	0.00	0.00
Less: Retirements			0.00	0.00	41.28	44.16	47.25	50.56	54.09	57.87	0.00	0.00	0.00
Closing Balance			275.90	295.22	253.94	209.77	162.52	111.96	57.87	0.00	0.00	0.00	0.00
Deprecation on Existing Plant			0.00	0.00	49.20	42.32	34.96	27.09	18.66	9.65	0.00	0.00	0.00
New Deprecation													
Opening Balance			0.00	0.00	0.00	70.79	147.42	230.40	320.25	417.57	522.99	575.29	575.29
Add: New Capitial Expenditures			FALSE	FALSE	70.79	76.63	82.97	89.85	97.32	105.43	123.09	134.16	134.16
Less: Retirements on New Plant			FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Closing Balance			0.00	0.00	70.79	147.42	230.40	320.25	417.57	522.99	575.29	632.82	632.82
Deprecation on New Plant			0.00	0.00	0.00	11.80	24.57	38.40	53.37	69.59	87.17	95.88	95.88
Total Modelled Depreciation			0.00	0.00	49.20	54.12	59.53	65.49	72.04	79.24	87.17	95.88	95.88
Theoretical Depreciation			42.98	45.98	49.20	54.12	59.54	65.49	72.04	79.24	87.17	95.88	95.88

If the historic growth rate is not constant, computing the implied growth from the accumulated depreciation ratio may not be precise and assuming the retirements follow a constant growth rate will not be perfect. However, an experiment with random growth demonstrates that the error is very small.

Depreciation Issues in Project Finance Models

In a project finance model, depreciation should be computed through establishing a gross plant balance account which increases with the construction costs over the construction period. To begin the depreciation at commencement of operation, the tax depreciation rate (which may vary with the age of the project) is multiplied by the balance of the plant as well as operating switch. As with the non-project finance models, the accumulated depreciation should be computed after the depreciation expense row. Computing depreciation can be complicated in a project finance model because of the manner in which tax depreciation is driven by the calendar year rather than the date the project begins operation. If the operation date is 27 December, the depreciation is the same as if the operation date is 5 January meaning it is much better to put the plant in service at the end of the calendar year. To resolve this problem, the number of calendar months in the year should be computed and the calendar year must be computed. Some techniques to accomplish this include:

1. Compute a switch for a new calendar year by making a test when the month of the start date is greater than the month of the end date using the MONTH function.
2. Use the switch to make a counter for the calendar year through accumulating the switch
3. Make an adjustment for the first operating year for which the counter should begin (you have to also make an adjustment so that you do not double count).
4. Use the COUNTIF function using both the range and the criteria as the annual year to find the number of periods per year.
5. The depreciation rate for the period is 1/life divided by the periods per year.

Modelling the Change in Deferred Taxes in Corporate Models

In making a corporate model, the measuring cash flow is one of the primary objectives. When evaluating cash flow, the taxes actually paid must be computed rather than the taxes booked. The taxes paid can be approximated by adding the change in deferred tax to taxes booked as illustrated by the formula below. This implies that you should compute deferred taxes in a model. Deferred taxes associated with tax loss carry forwards are computed a subsequent chapter discussing the profit and loss statement and deferred taxes associated with financing items such as fair valuation of derivatives are discussed in Part 3. This section explains how you deal with the painful issue of deferred taxes other than simply pretending that deferred taxes simply do not exist or that the change in deferred tax will always be zero.

$$\text{Taxes Paid} = \text{Taxes Booked} - \text{Change in Deferred Tax Liability}$$

The approach for computing changes in deferred tax related to capital expenditures and depreciation logically follows the mechanics of calculating depreciation. As with calculation of depreciation, it is convenient to separate the change in deferred tax between amounts associated with existing assets and amounts associated with new assets. For the new assets, tax depreciation can be computed once you know the tax depreciation life and the tax depreciation method. The vintage approach discussed above (incorporating accelerated depreciation methods for tax depreciation is often more relevant than for tax depreciation). With the tax depreciation computed, the change in deferred tax liability associated with new assets is simply the tax depreciation less the book depreciation multiplied by the tax rate:

$$\text{Change in Deferred Tax Liability} = (\text{Tax Depreciation} - \text{Book Depreciation}) \times \text{Tax Rate}$$

As with book depreciation, finding the change in deferred tax associated with existing assets is more difficult than computing deferred taxes associated with new assets. As the gross plant balance from the last historic year had to somehow spread across future years, the accumulated deferred tax associated with accelerated depreciation must also be determined. In the case of deferred tax, the manner in which the liability will reverse (representing a change in deferred tax) depends on how the deferred tax originally arose. You could use the find_base function described above; you could simply spread the deferred taxes over the remaining life on a straight line basis or you could come up with some other approach.

Adjusting the Tax Basis in an Acquisition

For tax purposes, an acquisition can be treated as a purchase of assets or a purchase of shares of stock. This tax treatment must be distinguished from the book accounting for an acquisition which results in re-valuation of assets and re-establishing the equity. If the acquisition involves a purchase of assets of assets rather than the purchase of stock for tax purposes, the acquisition price should be have a higher value as the asset base will be higher and the value of depreciation deductions increase. In evaluating an acquisition, comparative multiples should account for the difference in value from purchase of stock versus purchase of assets as the multiples should account for the difference in tax rates for different countries.

If the acquisition is a stock transaction, no write-up for tax purposes occurs, the seller does not pay tax on gain realized from selling asset and the buyer can use the existing net operating loss. For an asset

purchase the tax depreciation deductions take place over an extended period while the taxable gain must be paid immediately by the seller. Therefore, from the perspective of both the acquiring company and the target company on a combined basis, a stock transaction generally has a positive outcome because the gain on the sale is taxable as current income while the write-up is deducted on a periodic basis. On a present value basis, the government treasury wins and the combined shareholders of the two companies lose if the transaction is classified as an asset purchase. In situations with net operating loss, the situation is even worse as the value of the net operating loss carry-forward is lost.

To establish the tax and book depreciation expense in alternative transaction structures, the following steps can facilitate the development of a model:

1. The existing deferred taxes can be used to derive the existing difference between the tax and book base through dividing the accumulated deferred tax related to depreciation by the income tax rate.

$$\text{Existing Basis Difference} = \text{Accumulated Deferred Tax} / \text{Income Tax Rate}$$

2. In a stock transaction, the valuation of the assets increases for books, but the tax basis does not change. The difference in the basis increases the balance of accumulated deferred tax as demonstrated in the formula below.

$$\begin{aligned} \text{Accumulated Deferred Tax after Transaction} = \\ (\text{New Book Basis} - \text{Existing Basis}) \times \text{Income Tax Rate} \end{aligned}$$

3. When computing the goodwill for developing the pro-forma balance sheet, the increase in assets as well as the increase of accumulated deferred tax must be accounted for. In addition to other goodwill adjustments, the goodwill formula should include:

$$\text{Goodwill} = \text{Goodwill} - \text{Increase in Asset Valuation} - \text{Increase in Accumulated Deferred Tax}$$

Chapter 9: Adding Debt to a Corporate or Project Finance Model and How to Program Cash Flow Waterfalls that Define Who Receives Cash First and Where the Cash Flow Ultimately Goes

While much of the time spent in financial modelling should be studying and analysing value drivers, it is also important to accurately reflect the financial structure so the value drivers can be translated into cash flow projections that measures risk to alternative capital providers and the structuring of a transaction. Mechanical issues that translate free cash flow into effective analysis of the risk and value of debt and equity value discussed in much of the remainder of this chapter. This chapter addresses various modelling issues that arise when incorporating debt into a corporate, project finance, acquisition or merger model. The amount of debt that can be issued and maintained on the balance sheet is central to the general idea of using the risk analysis process of lenders to derive value of an investment which is central to many of the ideas presented in this text. Furthermore, the risk to lenders relative to the earned credit spread is also a critical subject in finance.

Given the importance of evaluating risks faced by lenders in finance, reflecting the specific features of debt is an essential part of the modelling process. These features include (1) the size of debt; (2) the repayment structure of the debt; fees paid and spreads on the debt; covenants and required debt service reserves. Depending on the transaction, the covenants and credit spreads may depend on financial ratios such as the debt service coverage or the ratio of debt to EBITDA. Similarly, the nature of debt issued in leveraged buyouts is a key driver of equity returns and the financial viability of the transaction. The structure of debt repayments, new debt issues and the credit spreads is also important in corporate

models and merger integration models as the amount of debt issued in a merger can be an important driver of the accretion or dilution in earnings per share.

Adding a Debt Schedule to a Corporate Model or a Project Finance Model after Free Cash Flow has been Established

The fundamental part of any debt schedule is defining the balance of debt outstanding and computing the interest expense from the balance of the debt. The debt outstanding should be structured by explicitly showing the opening balance, the new debt issues, the debt repayments and the closing balance on separate rows of the model. These debt balance schedules should be listed for each existing and prospective debt facility that will be present during the forecast horizon. For corporate models, the debt schedule should include all of the debt issues that are outstanding as of the last balance sheet date plus any new issues that may occur over the forecast period. In the case of project finance models, the debt issues include all of the different tranches of debt that are issued to finance construction as well as debt issues for letters of credit, defaults, and debt service reserves. For project finance models, debt schedules may be set up to include re-financing. Acquisition models generally include debt issues that are used in financing the acquisition as well as debt that was issued prior to the acquisition and that will be assumed by the new owners.

The starting point for the debt schedule that establishes the closing balance differs depending on the type of model. When developing corporate models, the closing balance of each debt balance is launched from the financial inputs which should list the amount outstanding in the base balance sheet year for each debt issue. The sum of these individual issues should correspond to the total amount of long-term debt on the balance sheet (including current maturities of short term debt.) If the sum of the closing balance of all of the debt issues does not equal the balance sheet amount, the prospective balance sheet will not balance and there will be an inconsistency in debt maturities and interest expense with actual financial obligations. Therefore, a verification check to assure that the total debt on the balance sheet equals the sum of the individual debt issues can be effective in verifying the model. The process of adding a debt schedule to a corporate model includes the following:

- Set-up the debt schedule with separate lines for:
 - o The opening balance
 - o Additions from new issues
 - o Subtractions from debt repayments
 - o The closing balance
- The initial closing balance is derived from inputs that tie to the balance sheet
- After the initial base period which is the last historic period, the subsequent opening balance is equal to the closing balance in the prior period

Once the opening and closing balance are established, the interest cost (whether capitalized or expensed) can be computed. For models that include capitalised interest or a cash flow sweep, it is convenient and sometimes essential to assume that repayments occur at the end of the period which means the opening balance is the basis of accrued interest. If the repayment occurs at the end of the period (say the payments to construction expenditures are made at the end of the month), then there is no accrued interest on borrowings related to the expenditures. Here, where everything occurs at the end of the period, the accrued interest is computed on the debt that was outstanding before the new debt was issued or repaid in the current period, which implies that the basis of interest expense is the opening balance. Unless the opening balance is used, hopeless circularity will arise. This idea of using the opening balance is consistent with actual payments of interest and is the primary reason periodic models are used rather than annual models. If the repayment occurs at the beginning of the period, the interest expense is computed on the closing balance. If the repayment occurs somewhere between the beginning and end of the period, the interest is a weighted average of the opening and closing balance.

Modelling Scheduled Debt Repayments

For many models, computing the debt repayment is the most complex element of the modelling process. The manner of repaying debt depends on the type of debt issue and the type of the model. Given the importance and the difficulty in computing debt repayments known as sculpting debt in project finance models, a separate section addresses the issue below. In other models, the repayment calculation can be derived from the opening balance of the debt. For example, in a corporate model where debt issues may be repaid on a single date – bullet repayments – a simple test can be created from the repayment year and this is used to assure that repayment only occurs on the repayment date. Specifically the programming involves:

- Add a line for the repayment of the debt after the opening balance
- Create a formula that compares the model year with the repayment year to create a logical variable (year = repayment year)
- Multiply the (year = repayment year) by the opening balance of the debt

The manner of debt repayment in a project finance model or a leveraged finance model is often tailored to the expected cash flows generated by the investment. For example, a project finance model may have a pre-defined set of repayment percentages that vary over the lifetime of the debt. Because of the percentages are applied to the aggregate amount of debt issued rather than the closing or opening balance it is generally a good idea to show the total accumulated amount of the debt on a separate line item above the debt balance. This accumulated balance can then be multiplied by the repayment percent or a tailored repayment schedule to establish the periodic repayments. Because of early debt repayments that can occur if covenants or cash sweeps are triggered, it is important to make sure that the amounts in the repayment row do not exceed the amount of debt outstanding. To program this, the MIN function can be used to assure that the amount being repaid does not exceed the opening balance of the debt as illustrated below. For leveraged acquisition models and/or integrated merger models, a combination of the corporate finance and the project finance approaches can be applied depending on the type of debt used to finance the acquisition.

$$\text{Repayment} = \text{MIN}(\text{scheduled repayment, opening balance})$$

Connecting Debt to Cash Flow in Corporate Model and Circularity Created by Interest Expense

In corporate models, it is useful to set up an account that sums the cash with the negative of the debt to reconcile the cash flow with the debt balance. The account is like other debt accounts except that it begins with the cash minus the short-term debt on the historic balance sheet. Unlike other accounts, the cash less debt amount is incremented with net cash flow on the balance sheet. For example, if there is a negative net balance on in the last historic year because of more short-term debt than surplus cash and the net cash flow is positive by more than this amount, then the cash is assumed to be used to pay-off the short-term debt and then build up in surplus balances. At the end of the period, if the net cash less short-term debt account is positive, surplus cash is placed on the balance sheet. If the account is negative, then the amount represents debt. To make this presentation, after the net balance has been established, the amount can be allocated to cash or short-term debt using the MAX function as illustrated below:

$$\text{Surplus Cash} = \text{MAX}(\text{Cash net of debt balance, 0})$$

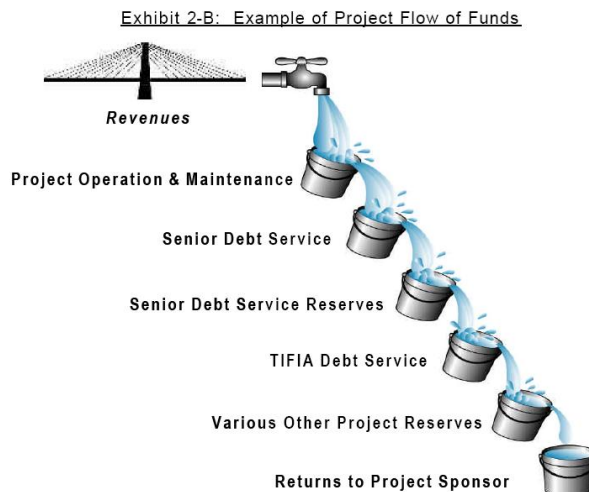
$$\text{Short-term Debt Balance} = \text{MAX}(-\text{Cash net of debt balance, 0})$$

In many models, a problem of circularity arises because interest expense drives cash flow, but the debt balance or the interest expense is affected by cash flow itself. The most common circularity problem in corporate models comes from the assumption that cash flows and therefore interest expenses occur in the middle of the year. (If monthly or even a daily model were constructed, the circularity would not arise because interest is paid on the opening balance of the debt and cash flow does not affect the opening balance.) If the assumption of interest expense on the opening balance cannot be applied (because an

annual model is constructed), then the interest expense affects cash flow, but the cash flow affects the debt balance and interest expense. As with most circular references, the problem arises because of an artifact of the financial model – in the real world bankers do not require interest expense to be paid using a circular formula where they first compute interest expense and then re-compute the interest expense because the debt is increased by interest expense. One solution to the circular reference problem is to click the iteration button in the excel options. However, the problem with this approach is that the iterative calculations can cause models to be unstable. A more elegant method is discussed in the chapter below on resolving circular references in corporate models.

A Few Effective Techniques to Model Any Cash Flow Waterfall

Any time debt is issued to finance capital expenditures and other items of a corporation, the uses of funds in a project financing or the purchase of a company, a loan agreement defines various restrictions on uses of cash to pay dividends, subordinated debt and other items. The manner in which a loan agreement establishes priorities in the use of cash flow is sometimes called a cash flow waterfall. A cash flow waterfall is somewhat analogous to multiple hydro plants in a cascade where water is held in reservoirs and allowed to flow down-stream by opening or closing various taps. If reservoirs are full, then the water can be allowed to flow down-stream. On the other hand, if reservoirs are empty, there may be requirements to fill-up the reservoir before any water can be used by subsequent hydro plants in the cascade. A cash flow waterfall that defines the priority of uses of cash is illustrated in the diagram below. For project finance models and acquisition models, modelling the mechanics of cashflow waterfalls that include cash flow sweeps, use and repayment of revolving credit facilities, cash trap covenants, top-ups and with-drawals from a debt service reserve accounts, debt defaults and repayment of defaults as well as interest and repayment of subordinated debt can be intimidating to model, much less analyse in a clear and concise manner.



In setting up a cash flow waterfall, you can apply a few ideas and make a seemingly complex waterfall easy to program in a financial model. The general ideas include: first setting up the debt schedule (including debt service reserve accounts); second, structuring the cash flow statement with a whole lot of subtotals; third, separately modelling what happens if cash flow is positive versus what happens when cash flow is negative using the MAX function; fourth assuring that you have not exceeded defined limits of debt using the MIN statement relative to the opening balance or the remaining allowed balance. Application of these four steps includes:

- ❖ First, set up the debt schedule and reserve balance schedule with opening balances, prepayments from sweeps, uses of revolving credit, repayments and availability, required balances uses and top-ups of debt service reserve accounts and the balance, debt defaults and repayment of defaults for the defaulted debt. Do not type in excel formulas until all of the cash flow statement is structured.

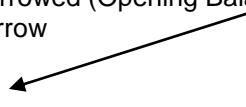
- For each item such as cash flow sweeps, defaulted debt, repayment of defaulted debt that comes from the cash flow statement, leave the amount in the debt schedule blank and just enter the title. Amounts from the cash flow statement should all be linked to the debt schedule at the end of the process meaning that all of the formulas to determine how much will be removed or placed in an account is taken from the cash flow analysis. For example, the senior debt schedule may be set up using the following account titles where the pre-payments from the cash sweep come from the cash flow statement:

Opening balance
Add: Debt Draws
Add: Capitalised Interest
Less: Scheduled Debt Repayments
Less: Pre-payments from Cash Sweep (Linked to cash flow statement)
Closing Balance

- For accounts such as letters of credit and debt service accounts one should set up accounts that track the remaining balance that can be used or the remaining funding that is required in the account. For a letter of credit, the remaining amount that is available for use is the total commitment less the amount that has already been borrowed. For a debt service reserve account, the amount that must be funded is the total required funding less the amount that is already in the account. Setting-up a letter of credit that can be used to fund deficit cash flow is illustrated below where the borrowings and the repayments come from the cash flow statement:

Total Debt Commitment
Less: Amount Already Borrowed (Opening Balance of Loan)
Remaining Amount to Borrow

Opening Balance of Loan
Add: Amount Borrowed: From Cash Flow Statement
Less: Amount Repaid: From Cash Flow Statement
Closing Balance



- ❖ Second, set up the cash flow account titles and the structure of the cash flow waterfall in the model without entering any formulas.

- In setting up titles include a whole lot of subtotals in the model design – after virtually every element, such as borrowings and paying back the working capital facility, the debt service reserve flows, the debt defaults and repayment of defaults, the cash flow sweep, and the cash trapped by the covenant. The order of priority in terms of which investor receives cash flows should be set-up in a cash flow analysis. An example of setting-up the cash flow analysis with sub-totals with a debt service reserve account, a letter of credit and defaults and a cash flow sweep is illustrated below (in a real model you would not include as much description):

Operating Cash Flow
Less: Interest Expense on Senior Debt
Less: Repayments of Scheduled Debt

Subtotal 1: Cash Flow after Scheduled Debt Repayment

Add: With Drawls from DSRA if Cash Flow is Negative

Less: Top-ups of DSRA if Cash Flow is Positive

Subtotal 2: Cash Flow after DSRA

Add: Uses of Letter of Credit if Cash Flow is Negative

Less: Repayment of Letter of Credit if Cash Flow is Positive

Subtotal 3: Cash Flow after Letter of Credit

Add: Defaults on Debt if Cash Flow is Negative

Less: Repayments if Cash Flow is Positive

Subtotal 4: Cash Flow after Default

Less: Cash Flow Sweep if Cash Flow is Positive

- In setting up titles for a flip structure, it is useful to set-up some supplemental accounts to establish the subtotals as illustrated below:

Total Cash Flow to Investors

Cash Flow to Senior Investors before Yield Constraint

Less: Cash Flow to Senior Investors before Yield Constraint

Subtotal 1: Cash Flow after Senior Investors before Yield Constraint

Cash Flow with Yield Constraint/Cash Flow to Senior without Constraint

Subtotal 2: Cash Flow to Senior Investors after Yield Constraint

Less: Cash Flow to Senior Investors after Yield Constraint (1-percent) x Total Cash

Subtotal 3: Cash Flow to Junior Investors

- ❖ Third, enter formulas for each step of the cash flow waterfall differently depending on whether the cash flow is positive or negative using a combination of the MAX and MIN functions. As you get used to using the MIN and the MAX functions, you will forget any idea about using IF statements that make the formulas less transparent.
 - Use the MAX(cash flow,0) function to test for positive numbers and use the MAX(-cash flow,0) to test negative numbers. For example, if the cash flow after senior debt service is negative, then you should draw from the revolving credit account and use MAX(-number,0) while if it is positive you should use available cash to repay balances and apply the MAX(number,0) function.
- ❖ Fourth, in determining how much cash is available or must be used to pay back items, use the MIN function and test the amount against the opening balance.
 - Virtually all of the calculations in the cash flow waterfall will include both a MIN and a MAX function, but this does not mean that the formulas are too complex. For example, when modelling the amount of cash flow that is borrowed from the letter of credit account, the formula should look something like:
 - MIN(opening balance of available to borrow, MAX(-cash flow,0))
 - If cash flow is positive, then the second component of the formula is zero and the minimum of zero or the balance available will be zero. When the cash flow is positive, then the positive cash flow can be used to repay amounts in the working capital facility as shown in the formula below -- if the opening balance is paid off, then the formula will result in zero as it will if the cash flow is negative:
 - MIN(opening balance of revolving debt, MAX(cash flow,0))

- In modelling a flip structure, use the MIN command to compare the opening balance of the yield tracking account and the cash flow that would accrue to the senior investors if there was no constraint on the yield. The MIN function combined with the tracking account can be used to find the time at which the yield is realized.

- MIN(Opening balance of tracking account, cash flow)

❖ Fifth, link accounts in the cash flow waterfall to the debt schedule.

- In attaching accounts, the formulas in the debt schedule should be all be simple links, as the evaluations with MAX and MIN formulas have been made in the cash flow analysis. The rule is to keep the formulas in the debt schedule extremely simple.

Revolving Credit Facility								
Commitment	300	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Less: Amount Already Borrowed		-	168.65	300.00	300.00	300.00	300.00	-
Remaining Amount to Borrow		300.00	131.35	-	-	-	-	300.00
Opening Balance		-	168.65	300.00	300.00	300.00	300.00	-
Add: Borrowings		168.65	131.35	-	-	-	-	-
Less: Repayment		-	-	-	-	-	300.00	-
Closing Balance		168.65	300.00	300.00	300.00	300.00	-	-
Interest Rate		5%	7%	6%	6%	7%	2%	0%
Interest Expense		-	11.81	18.00	16.50	21.00	7.06	-
Defaulted Debt								
Opening Balance		-	-	6.82	166.18	275.51	968.08	-
Add: Defaults		-	6.82	159.36	109.33	692.57	-	-
Less: Repayments of Default		-	-	-	-	-	968.08	-
Closing Balance		-	6.82	166.18	275.51	968.08	-	-
Sub Debt								
Opening Balance		100.00	106.67	117.33	129.07	141.97	156.17	-
Add: Interest Capitalised		6.67	10.67	11.73	12.91	14.20	5.25	-
Less: Repayment at Exit		-	-	-	-	-	161.42	-
Closing Balance	100.00	106.67	117.33	129.07	141.97	156.17	-	-

Defaults on Debt and Measuring the Potential Decline in Debt IRR below the Stated Interest Rate

In using a model to assess an investment with debt financing, a useful task is to determine at what point a loss on the loan occurs. When a loss on debt occurs, the interest rate or the IRR realized by lenders is less than promised interest rate and attempts to restructure the debt have not allowed temporary defaults to be repaid. Modelling the point at which defaults on debt occur is useful in credit analysis because one of the objectives of credit analysis is to measure the probability of default as well as the loss given default relative to the credit spread that compensates for risk. Through explicitly modelling defaults, one can analyse at what point the cash flow is insufficient to repay the debt after restructuring. The IRR earned on debt can be computed in a similar manner to the equity IRR where cash outflows made by equity holders are compared to the dividends received in the pockets of the equity holders. In the case of the debt IRR one can measure the cash flow dispersed to lenders and then the debt service received by lenders. Once the realized IRR on debt is computed through accounting for defaults, the risk of debt can be evaluated through break-even analysis, scenario analysis and Monte Carlo simulation. For example, by incorporating defaults on debt in a model, the break-even level of EBITDA can be computed. The probability of achieving this break-even level of EBITDA can then be used to assess the credit spread of the loan.

The process of incorporating defaults into a financial model involves linking the cash flow statement with the debt schedule using the cash flow waterfall concepts discussed above. The amount of defaults is

determined in the cash flow statement using a subtotal account. The amount of default that can be repaid is calculated if there is an opening balance in the default account and if the cash flow after other obligations is positive. The following step by step process can work through how to compute the defaults:

- Step 1: Set up the a debt balance schedule for the defaulted debt with line items that include the opening balance of defaulted debt, the additions to the defaulted balance from defaults, the repayments of default from positive cash flow and the ending balance of defaulted debt.
- Step 2: Compute a sub-total cash flow account after the scheduled debt is paid and after all possible other contingent accounts have been used including the debt service reserve accounts, letters of credit and working capital facilities. Compute the defaults in a row below this sub-total when the amount in the sub-total is negative implying that there is an inability to meet debt service. The amount of the default is limited to the amount of debt service that is assumed to be paid and can be computed using the formula $\text{MAX}(-\text{cash flow}, 0)$ along with a MIN function that limits the default to the total debt service. The following formula represents computation of the defaults on debt:

$$\text{Default} = \text{MIN}(\text{debt service}, \text{MAX}(-\text{cash flow}, 0))$$

- Step 3: Link the defaults in debt to the defaulted debt schedule. As for other items in the cash flow waterfall such as the debt service reserve account and letters of credit, calculations of cash flow movements should be made in the cash flow statement where they can be directly to subtotals and the only formula in the defaulted debt schedule should be a link.
- Step 4: Below the debt defaulted row in the cash flow statement, set-up as line for the re-payment of default. The repayment of default is a function of the cash flow and the amount of debt default. Repayment of cash flow only occurs when the cash flow is positive meaning an MAX function should be used. The repayment of default cannot be above the total amount of the defaulted which means it should be capped by the opening balance of the defaulted debt. This means the defaulted debt is the minimum of the positive cash flow or the opening balance of the defaulted debt as shown in the formula below. Once the repayment of the default is computed in the cash flow waterfall using the formula above, link the repayment of default to the debt schedule.

$$\text{MIN}(\text{opening balance of defaulted debt}, \text{MAX}(\text{cash flow}, 0))$$

- Step 5: Compute the cash flow realized by lenders for purpose of computing the debt IRR and the debt NPV through deducting defaults and adding re-payment of defaults to the scheduled debt service. The debt cash flow is demonstrated in the following formula:

$$\text{Debt cash flow} = \text{Interest paid} + \text{repayments} - \text{defaults} + \text{repayment of default} - \text{cash debt invested}$$

A diagram that is intended to illustrate the link between the cash flow statement and the debt balance is presented below. The diagram below illustrates that the default comes from the cash flow statement, the repayment of default comes from the earlier default, and the repayment of default is put back into the cash flow statement.

Including Subordinated Debt with the Ability to Assess Risk and Return Characteristics of Subordinated Debt Relative to Senior Debt

The most basic issue in finance is assessing risks and returns from an investment. This issue is highlighted in analysis of subordinated debt where the higher credit spread on subordinated debt must be evaluated relative to the higher risk of subordinated debt relative to senior debt. To evaluate the risk of subordinated debt, a financial model must be able to determine the point at which the loss occurs and the risk and return characteristics of the subordinated debt. In modelling subordinated debt, the first step is to include the debt in the sources and uses analysis. When developing the subordinated debt schedule, it is possible that interest is capitalized and added to the balance of the debt. In the final period

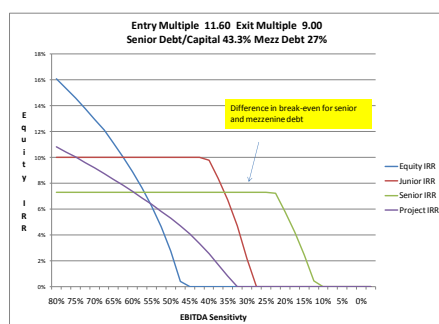
when the subordinated debt matures, the amount of the debt repayment is the sum of the opening debt balance and the interest capitalized for the final year.

Once the debt schedule is established for subordinated debt, the cash flow statement must reflect the priority of the subordinated debt relative to other debt service. If debt with differing priority is included in the cash flow statement, then a cash flow waterfall should be modelled that reflects the specific provisions including the interest, repayment of debt service, covenants and sweeps of the alternative debt. When structuring the cash flow statement with alternative priorities, it is essential that the ordering of titles in the cash flow analysis conform the ordering of cash flows in the loan documents. For example, if there is a cash flow sweep for senior debt and junior debt interest is not capitalized, then the senior debt sweep must occur after the junior debt interest payments.

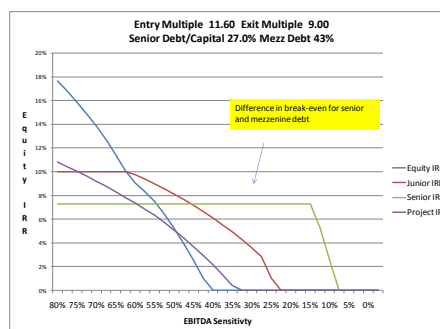
To illustrate how a model can be used to assess the risk of senior versus subordinated debt, a sensitivity analysis can be performed of the EBITDA in terms of senior IRR, subordinated IRR, equity IRR and the overall project IRR. The difference in points at which the senior IRR and the junior IRR crosses is a measure of the risk. In the diagram below the case with more subordinated debt has more risk as demonstrated by the break-even points.

IRR on Senior versus Junior Debt with Different Capital Structures

- More Senior Debt



- More Subordinated Debt



Chapter 10: Alternative Calculations of How Different Shareholders are given Cash Flow -- Flips, Earn Outs and Management Incentives

Shareholder agreements or partnership agreements may define the manner in which senior investors receive a priority on cash flow available after debt in an analogous manner to the way in which loan agreements define priorities on cash flow before equity distributions. Some agreements may distribute dividends using complex formulas rather than simply allocating common dividends in a proportionate all shareholders. These structures can involve a flip where one group of shareholders is allocated the majority of dividends until a given IRR criteria is met. After achieving the IRR target, the dividend distribution scheme changes and the second investor receives a majority of the dividends. Other structures can allocate upside to management or to developers after some criteria is met. For example, management may receive 10% of the excess cash flow after a given IRR is obtained. Finally in acquisition transactions, earn out provisions can be established whereby a portion of the purchase price is allocated to existing owners, but they are only allowed to share in upside profits after a certain target is obtained.

The cash flow sharing that is part of shareholder agreements is analogous to cash flow waterfall applied to equity cash flow. In modelling a cash flow waterfall applied to equity distributions, the formula for

receiving the dividends must be understood as is the case for priorities in the debt waterfall. If dividends are not distributed in a proportional manner, there must be some kind of trigger mechanism or formula that changes the distribution among investors. Some of the investors receive an implicit priority on cash flow either through a shareholder loan or the right to a higher proportion of dividends before some kind of target is met. As with the debt waterfall, the investor that has the highest priority claims on cash flow should be modelled in an analogous manner to the senior debt. Complexity in modelling the equity cash flows can arise if the criterion is based on an IRR limit as described above. One could compute a rolling IRR, but then one would have to allocate cash in the period in which the target IRR is obtained. In this period when the IRR has just been achieved, some of the cash flow is allocated to one investor and some is allocated to a second investor. To model a flip structure the following process can be developed:

First, set-up an equity tracking account (somewhat analogous to a debt balance account) that reaches a level of zero once the IRR target is achieved.

Second, set-up the cash flow statement titles in order of the claims where the senior claim to the equity cash flow is listed first.

Third, after the first tranche is computed, distribute the income according to percentages.

A yield tracking account should be created when modelling a flip structure where a senior investor receives a proportion of cash flows until an IRR yield is met, and a second investor receives the remainder of the cash and a different proportion after the yield is reached. The yield tracking account keeps track of the balance due to the senior after taking account of the earnings that must be realized for the yield to be met. The tracking account is similar to the other accounts except that the opening balance is increased by the yield that must be earned as illustrated below:

Opening Balance
Add: Earnings on Investment (Opening Balance x Required Yield)
Sub-total
Less: Dividends Distributed to Senior Partner
Closing Balance

In this account, the dividends cannot exceed the sub-total balance as the yield will be exceeded. To cap the dividends at the sub-total, the distributed dividends can be computed as: $\text{MIN}(\text{subtotal}, \text{dividend formula})$

Chapter 11: The Last Step in Creating a Financial Model -- Putting Together Financial Statements and Tricky Issues in Calculating Income Taxes

Once a working module that computes revenues, expenses and working capital is established along with the depreciation schedule and the debt schedule, the profit and loss statement should be simple to calculate. In a corporate model, the profit and loss statement is essential as the net income defines the earnings per share and the return on equity. For a project finance model, calculation of the profit and loss statement is required to develop taxes. A nice way to structure the profit and loss statement is to begin with EBITDA and then subtract various items to end up with E (earnings). The EBITDA can be computed from the revenues and cash operating expenses (you often have to allocate depreciation expense to cost of goods sold and find depreciation on the cash flow statement or the notes). Operating expense and revenues are already defined in the operating analysis. Depreciation and amortization (DA) can then be subtracted resulting in EBIT. The depreciation expense is already defined in the plant balance and depreciation section. After computing EBIT, interest expense is subtracted and interest income is added resulting in EBT. The interest expense and interest income is taken from the debt schedule. With EBT established, book taxes – the single calculation in the profit and loss statement that

is not a subtotal -- are computed through multiplying the EBT by the tax rates and subtracting minority interest overall earnings can be computed.

Cash taxes are a somewhat more difficult to compute than deriving book profit, although the calculation is not too painful if taxes are structured properly when setting-up a model. The computation of taxes can have an important effect on capital intensive projects such as renewable energy projects where rapid tax depreciation may be allowed, but the taxable income is not sufficient to use all of the tax deductions (including high levels of interest expense at the beginning of the modelling period.) As with the other mechanical issues regarding construction of a model one of the most important elements is simply not to be afraid to either read or construct the tax section of models. An effective way to compute taxes paid is to add a separate tax schedule after the profit and loss statement that lays out the taxes paid from a net operating loss carryforward analysis. Incorrect computation of taxes paid and simplistic accounting for taxes may cause big problems in measurement of cash flow and valuation.

Not Being Intimidated by Computation of Taxes Paid and Taxes Deferred

A modelling process that will model taxes is to first compute the taxes on the books and the cash taxes actually paid. One of the things that may seem a little difficult is to incorporate net operating loss carry forwards. After the income statement is completed, the EBT from the income statement can be used as the first step for computing the true cash taxes that are actually paid (book taxes can be negative but actual taxes paid must be positive). From the book EBT, adjustments can be made that convert the EBT for books into the earnings before taxes for purposes of computing taxes paid. These adjustments generally involves adding back book depreciation and then deducting tax depreciation, adjusting for intangible amortisation and other items. Once the adjustments are made, the taxable income for purposes of computing cash taxes can be computed. After the taxable income is derived, adjustments for a net operating loss carry forward can be made. This involves determining the balance of the net operating loss and making adjustments that increase or decrease the carry forward balance. Once the cash taxes are established, the change in deferred taxes can be calculated along with the accumulated deferred tax. To compute the taxes paid and the taxes deferred, one can following the following step by step process in a module below the income statement.

- Step 1: Create a row that repeats the EBT from the income statement.
- Step 2: Adjust the book EBT for depreciation and other items that cause cash taxes to differ from the taxes reported on the book profit and loss statement.
- Step 3: Set-up an account that maintains the net operating loss balance including the opening balance, the additions that occur when there is negative taxable income and the deductions that occur when the net operating loss is used to reduce taxes that would otherwise be paid when there is taxable income.
- Step 4: Compute the amounts deposited into the account from negative taxes through converting the negative amounts into positive numbers. As with the cash flow waterfall, use the MAX function to convert negative numbers into positive numbers and cap the negative numbers at zero.
- Step 5: Calculate the amounts removed from the operating loss balance through determining the minimum of the opening balance and taxable income. This is again similar to the cash flow waterfall where MIN and the MAX functions are used together – the MIN function limits the use to the taxable income or the opening NOL balance.
- Step 6: Compute the adjusted taxable income after adjusting for inflows and outflows from the operating loss account.
- Step 7: Multiply the adjusted taxable income by the statutory tax rate to determine the cash taxes.
- Step 8: Subtract the book taxes from the cash taxes to determine the change in accumulated deferred taxes.
- Step 9: Accumulate the deferred taxes through adding the changes in deferred taxes to the prior years balance. If the accumulated deferred taxes are positive, put the balance on the liability side of the balance sheet and if they are negative, change the sign and put the account on the asset side of the balance sheet.

	1	2	3	4	5	6	7
EBT - Book	(500.0)	(300.0)	100.0	200.0	300.0	400.0	500.0
Tax Expense	(137.5)	(82.5)	27.5	55.0	82.5	110.0	137.5
Net Income	(362.5)	(217.5)	72.5	145.0	217.5	290.0	362.5
EBT - Book	(500.0)	(300.0)	100.0	200.0	300.0	400.0	500.0
Less: Added Dep for Tax	100.0	100.0	100.0	(100.0)	(100.0)	(100.0)	
EBT - Tax	(600.0)	(400.0)	-	300.0	400.0	500.0	500.0
NOL							
Opening Bal	-	600.0	1,000.0	1,000.0	700.0	300.0	-
Add: Tax Losses	600.0	400.0	-	-	-	-	-
Less: Used NOL	-	-	-	300.0	400.0	300.0	-
Closing Balance	600.0	1,000.0	1,000.0	700.0	300.0	-	-
Taxes w/o NOL	(165.0)	(110.0)	-	82.5	110.0	137.5	137.5
Add: NOL Inflows	165.0	110.0	-	-	-	-	-
Less: Outflows	-	-	-	82.5	110.0	82.5	-
Taxes Paid	-	-	-	-	-	55.0	137.5
Deferred Tax	(137.5)	(82.5)	27.5	55.0	82.5	55.0	-
Accumulated Deferred Tax	(137.5)	(220.0)	(192.5)	(137.5)	(55.0)	-	-

If the tax law includes provisions whereby NOL can be lost after a certain period of time, the calculations become more complex. The problem is that one needs to look backwards to find when the NOL is lost and more importantly, the losses do not include NOL balances that have already been used. To compute a more complex NOL calculation, the OFFSET function can be used along with a balance that maintains the accumulated NOL's that have already been used. The OFFSET can be used with a row and column indicator to compute the maximum amount that can be lost which is the amount that was created in the lagged year. The amount of NOL used is then accumulated and reduced using the MIN function as shown below.

Tax Rate	20%												
Carryforward period	3												
	1	2	3	4	5	6	7	8	9	10	11	12	13
EBT	200	-200	-300	100	-10	50	20	-20	-50	10	15	20	15
NOL Balance													
Opening Balance	-	-	200.0	500.0	400.0	310.0	-	-	20.0	70.0	60.0	35.0	-
Less: NOL Lost	-	-	-	-	100.0	300.0	-	-	-	-	10.0	35.0	-
Remaining NOL	-	-	200.0	500.0	300.0	10.0	-	-	20.0	70.0	50.0	-	-
Add: Losses	-	200.0	300.0	-	10.0	-	-	20.0	50.0	-	-	-	-
Less: NOL Used	-	-	-	100.0	-	10.0	-	-	-	10.0	15.0	-	-
Closing Balance	-	200.0	500.0	400.0	310.0	-	-	20.0	70.0	60.0	35.0	-	-
Switch	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
NOL from Lagged Period	-	-	-	-	200.0	300.0	-	10.0	-	-	20.0	50.0	-
Amonunt Used													
Opening Balance	-	-	-	-	100.0	-	10.0	10.0	-	-	10.0	15.0	-
Add: Used from above	-	-	-	100.0	-	10.0	-	-	-	10.0	15.0	-	-
Less: Expired with MIN	-	-	-	-	100.0	-	-	10.0	-	-	10.0	15.0	-
Closing Balance	-	-	-	100.0	-	10.0	10.0	-	-	10.0	15.0	-	-
Amount Lost (Lagged - Expired)	-	-	-	-	100.0	300.0	-	-	-	-	10.0	35.0	-
Adjusted EBT	200.0	-	-	-	-	40.0	20.0	-	-	-	-	20.0	15.0
Taxes	40.0	-	-	-	-	8.0	4.0	-	-	-	-	4.0	3.0

Cash Flow Statement and Balance Sheet

The structure of all of the financial model types includes a cash flow statement and a balance sheet as the final part of the model structure. Complicated issues associated with the cash flow statement were discussed above in the context of the cash flow waterfall and the cash flow statement should have a similar presentation to the cash flow waterfall. Other than the cash flow waterfall, programming the cash flow statement and the balance sheet simply involves linking the rows with other calculations that have already been made. The only calculation that is not a simple sub-total in a cash flow statement is for

dividends. A separate section is included for these parts of the model in order to be comprehensive and because of the importance of structuring the sheet.

Most of the time it is better to begin a cash flow statement with revenues, expenses and EBITDA rather than net income. If net income is the starting point, then interest expense and interest income are already included in net income. To compute a cash flow waterfall, the senior interest may have to be separated from subordinated interest expense and interest income generally is available for cash flow. Other than the MIN and MAX statements that are used to define the cash flow priorities every item on the cash flow is either a sub-total or directly comes from the debt schedule, the income statement, the working capital module and other places. The end of the cash flow statement is different depending on the type of model. For corporate models and integrated models, the dividends are included in the financing section of the model and the end of the cash flow statement is surplus or deficit cash flow that feeds into the short-term debt and the surplus cash. In the case of project finance models and acquisition models, changes in cash are included as required reserve accounts such as the debt service reserve account and the last line is the dividend distribution.

Other than the model outputs and the risk analysis, the last part of a model is computation of the balance sheet. For people who have done a lot of modelling, seeing the balance sheet balance is a wonderful feeling. To the contrary, not being able to find where the balance sheet has gone wrong is a nightmare. For the balance sheet to be an effective auditing tool, each item in the balance sheet should be already computed in the model and you should simply find all of the closing balances and link them to the balance sheet. The balance of accounts receivable, cash, plant, debt should already exist. For other assets on the balance sheet that are not modelled in detail such as investments, debt issuance cost associated with capitalized underwriting fees and operating reserve accounts, balances should be established. A separate account can be created for the book balance of assets and the tax balance of assets if there is a difference in depreciation methods or in the basis for depreciation. The balance of equity capital that includes the effects of net income and dividends should be presented before the balance sheet but after the cash flow statement. A similar presentation should be made for minority interest which derives items from the balance sheet and the cash flow statement.